Asbestos

Volume 1 : final report of the advisory committee

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Asbestos

Volume 1 : final report of the advisory committee

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Preface

This is the third and final report which the Advisory Committee on Asbestos has presented to the Health and Safety Commission and Ministers. Since their appointment in 1976, members of the committee have provided and received a large volume of information and advice on a subject which has not previously been studied in such a systematic way. The committee has already produced two reports on specific aspects of asbestos and the Commission welcomes this culmination of their work as an important contribution to improving the health and safety of the community as a whole.

The committee's terms of reference were wide, so this report covers the occurrence and use of asbestos within, around and outside the workplace as it affects employers, employees and the general public. Within this broad field, the Commission agrees with the emphasis placed by the committee on controlling exposure to asbestos at work as, besides helping to reduce possible health risks to employers and employees, it will directly affect exposure and related possible health risks to the general public. While not necessarily endorsing all the recommendations made in this report, the Commission therefore see the committee's recommendations for control limits and their revised levels for different types of asbestos as of particular importance.

Arrangement of the report

In considering how best to present the report, committee members and the Health and Safety Commission were very conscious of the need to make the conclusions easily accessible and understood by general readers, while at the same time including sufficient detail for those with special interests.

Too much technical detail tends to discourage all but the professionals most closely concerned. However, we believe that it is necessary to keep some of the technical detail in the main text of the report because many of the most important recommendations are based on the technical and medical information received.

We have therefore tried to strike a balance by publishing the report in two volumes. This first volume contains the main text of the report, setting out the principal facts and argument on which the conclusions are based, including much of the closely related detail in Appendices. For convenience it also contains a summary of the recommendations from the two previous reports *Work on Thermal and Acoustic Insulation and Sprayed Coatings* and *Measurement and Monitoring of Asbestos in Air*. These reports were published as consultative documents on 1 June 1978.

The second volume comprises the papers commissioned by the Advisory Committee and used in preparing the report. *The Ill Effects of Asbestos Upon Health*, by ED Acheson and MJ Gardner is the full report from which the agreed summary at Chapter 3 in Volume I is drawn. Material from *Asbestos Control Limits* by J Steel is assimilated more fully into the main text but is particularly relevant to Chapters 3 and 4. The third paper contains information on the experience of controlling exposure to asbestos in other countries, and the fourth gives the results of an exploratory survey into the technical feasibility of substitution for asbestos in particular uses. The second volume concludes with a list of the organisations and individuals who gave evidence to the committee.

This report has far reaching implications for future policy, and comments on its contents would be welcome. Its scope extends beyond the Commission's sphere of responsibility but, as with the committee's earlier publications, it has been agreed with government departments and other organisations concerned that any comments should in the first instance be sent in writing to Miss SC Newton, Health and Safety Executive, 25 Chapel Street, London, NW1, by 31 January 1980.

W SIMPSON

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Prohibition; identification of crocidolite in insulation materials and sprayed coatings; substitution; control limits: criteria for determination, sampling and evaluation, application of criteria, a longer-term solution; other controls in the workplace; exhaust ventilation equipment; protective equipment; asbestos hazard areas; medical supervision; Appendices L, M, N.

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Foreword

Background to the appointment of the committee

Asbestos has long been suspected to be a hazardous substance. However, it was not until the late 1920's that asbestosis was first clearly recognised as an occupational disease. As a result, the Asbestos Industry Regulations were made in 1931 under the Factories Act. However, these Regulations had three drawbacks: they did not apply to all occupations carrying a risk of exposure to asbestos; they took no account of the mesothelioma and lung cancer hazards (which were then unknown); and they did not attempt to control any public health risks that might exist. To endeavour to rectify the first two drawbacks, the new asbestos regulations were introduced under the Factories Act in 1969. These extended coverage to many workers not covered by the older regulations, but they still reflected relative ignorance about the risks of mesothelioma, lung cancer and possibly other cancers.

In 1971, the Department of Health and Social Security's Standing Medical Advisory Committee, chaired by Sir Richard Doll, prepared a report on the health risks from asbestos. This report recommended that the use of different types of asbestos in this country, the extent to which the public is exposed to asbestos dust and the hazard associated with this exposure should be reviewed in five years time from the introduction of the 1969 Asbestos Regulations. By 1975, there was also public concern about the possible exposure of members of the public to dust from asbestos waste on landfill sites and from consumer products. For these reasons, Ministers decided that a wide-ranging review of the health risks from asbestos by an Advisory Committee was called for, to report to Ministers and the newly created Health and Safety Commission.

Membership and terms of reference of the committee

On 30 March 1976, Mr Michael Foot, then Secretary of State for Employment, announced that with the agreement of Ministers the HSC were to set up a committee with the following terms of reference:

'*To review the risks to health arising from exposure to asbestos or products containing asbestos including :*

> *persons exposed at work;*
>
> *members of the public exposed to asbestos generated from work activities;*
>
> *members of the public exposed to asbestos from consumer products and from asbestos waste;*

to make recommendations as to whether any further protection is required. The Committee's report would be for the consideration of the HSC and Ministers and would be published'.

On 18 May 1976 Mr Albert Booth, as successor to Mr Foot, announced the membership of the committee. This in part reflected that of the HSC and was chaired by the Chairman of the Commission. Out of the fifteen members, three were nominated by the TUC, three by the CBI, one member was a member of the National Consumer Council, and Consumers' Association; one represented local authorities and seven were independent medical and scientific experts. Thus a wide range of national interests and disciplines concerned with the health risks of asbestos were represented.

Organisation of the work of the committee

At the first meeting of the committee on 23 June 1976, it was decided to set up four working groups to assist the committee on more detailed work in various spheres. These groups were:

Medical (Chairman Dr KP Duncan, Director of Medical Services, Health and Safety Executive).

Environmental Monitoring (Chairman Dr GW Bloomfield, Director of Occupational Medicine and Hygiene Laboratories, Health and Safety Executive).

Legal and Administrative Controls (Chairman Mr HJ Dunster, Deputy Director-General, Health and Safety Executive).

Production and Use of Asbestos-containing Products (Chairman Dr CJ Stairmand OBE).

Later a fifth group was set up:

Substitutes and Substitution (Chairman Mr P Gerosa, succeeded by Mr H Ellis-Rees, Under Secretaries, Department of the Environment).

The result of the deliberations of these working groups were important contributions to the committee's work.

Evidence from the public

When the membership of the committee was announced, interested parties were invited to submit evidence. By March 1977, thirty-four organisations and members of the public had done so, and a selection of this evidence was printed as *Selected Written Evidence Submitted to the Advisory Committee on Asbestos 1976–77* (HMSO). On 27, 28 and 29 June 1977 the committee held meetings open to the public at which twelve of the contributors expanded on their evidence orally and answered questions from committee members.

Previous publications

This report follows our interim statement* and earlier reports on specific aspects of asbestos† and sets them in the context of our general view of the risks to human health from exposure to asbestos dust. Many comments have been received on these publications which have helped the Advisory Committee in our further considerations and the Health and Safety Executive (HSE) in deciding how best to act on our earlier recommendations.

We are most grateful to everyone who has submitted evidence or supplied information to the Advisory Committee or its working groups at all stages of our work.

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* Advisory Committee on Asbestos: Asbestos - Health Hazards and Precautions (An Interim Statement by the Advisory Committee on Asbestos) Health and Safety Commission, 1977.

† Advisory Committee on Asbestos: Work on Thermal and Acoustic Insulation and Sprayed Coatings, Health and Safety Commission, 1978.

Advisory Committee on Asbestos: Measurement and Monitoring of Asbestos in Air, Health and Safety Commission, 1978.

Membership of the Advisory Committee and the working groups

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Chairman

W Simpson, *Chairman, Health and Safety Commission*

Members

Prof ED Acheson, *Dean, Faculty of Medicine Southampton University*

AC Blyghton, *Secretary, Legal Department, Transport and General Workers Union*

The Hon P Bradbury, *Chairman, Safety, Health and Welfare Committee, Confederation of British Industry*

Dr JC Gilson, CBE, *Formerly Director, Medical Research Council Pneumoconiosis Unit, Penarth*

HDS Hardie, OBE, *Director, Turner and Newall Limited*

W Lewis, *Organisation Officer, Union of Construction, Allied Trades and Technicians*

WD Lomas, *Assistant General Secretary, National Union of Dyers, Bleachers and Textile Workers*

Prof A Mair, *Professor of Community and Occupational Medicine, Dundee University*

Dr M Molyneux, *Occupational Hygienist, Institute of Naval Medicine*

Dr CJ Stairmand, OBE, *Consultant Chemical Engineer and Physicist*

Dr J Steel, *Senior Lecturer, Department of Occupational Health and Hygiene, University of Newcastle upon Tyne*

FG Sugden, MBE, *Chief Environmental Health Officer, Middlesbrough*

Prof M Turner-Warwick, *Professor of Medicine* (*Thoracic Medicine*), *University of London*

AW Ure, *Director, Trollope and Colls Limited*

Mrs R Waterhouse, *Member of National Consumer Council, Member of Council of Consumer Association*

Secretary to 30 June 1978

CD Burgess, *Hazardous Substances Division, Health and Safety Executive*

Secretary from 3 July 1978

BM O'Reilly, *Hazardous Substances Division, Health and Safety Executive*

WORKING GROUPS

** Denotes members of the main committee*

Medical

Dr KP Duncan (*Chairman*), *Director of Medical Services, Health and Safety Executive*
Prof ED Acheson*
AC Blyghton*
Dr JC Gilson*
Dr G Leathart, *Senior Lecturer, Dept of Industrial Health, University of Newcastle upon Tyne*
Prof A Mair*
Prof JC McDonald, *Director, TUC Centenary Institute of Occupational Health, London University*
Dr R Owen, *Medical Adviser, TUC Congress House, London WC1*
Dr J Steel*
Prof M Turner-Warwick*

Environmental Monitoring

Dr GW Bloomfield (*Chairman*), *Director, Occupational Medicine and Hygiene Laboratories, Health and Safety Executive*
Dr S Beckett, *Institute of Occupational Medicine, Edinburgh*
Dr A Critchlow, *Research and Laboratory Services Division, Health and Safety Executive*
H Fagan (*representing* W Lomas), *National Union of Dyeworkers, Bleachers and Textile Workers*
Dr S Holmes, *TBA Industrial Products, Rochdale*
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Dr M Molyneux*
Dr LE Reed, *Central Unit on Environmental Pollution, Dept of the Environment*
FG Sugden*
Dr V Timbrell, *Medical Research Council, Pneumoconiosis Unit, Penarth*
R Wagg, *HM Factory Inspectorate, Health and Safety Executive*
Dr R Wood, *Laboratory of the Government Chemist*

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AC Blyghton*
AJ Cotsell, *Building Regulations Division Dept of the Environment*
D Everett, *Hazardous Substances Division Health and Safety Executive*
AD Fagin, *Waste Management Division, Dept of the Environment*
D Gee (*succeeded* H Whitty), *Health and Safety Officer, General Municipal Workers Union*
HDS Hardie*
Glyn E Jones, *Chief Executive and Town Clerk, Gillingham Borough Council*
DR King, *Consumer Safety Unit, Dept of Prices and Consumer Protection*
GS Lyndon, *Superintending Inspector, Health and Safety Executive*
Dr M Molyneux*
Mrs R Waterhouse*

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HDS Hardie*
K Humphreys, *Building Regulations Professional, Dept of the Environment*
SL Hunt, *Southern Demolition Co Ltd*
A Jones, *Chief Architect, John Laing Design Associates*
W Lewis*
A McLean, *Branch Chairman, Thermal Insulating Board, National Union of General and Municipal Workers*
AW Ure*

Substitutes

PN Gerosa, *Chairman* (*for meetings on 20 April 1977 and 6 June 1977*) *Construction Industries Directorate, Dept of the Environment*
H Ellis-Rees, *Chairman* (*for all subsequent meetings*), *Construction Industries Directorate, Dept of the Environment*
The Hon P Bradbury*
DF Cornelius, *Building Research Establishment, Dept of the Environment*
W Godson, *Property Services Agency, Dept of the Environment*
M Gordon, *Greater London Council Architect*
GF Heron, *TBA Industrial Products*
K Humphreys, *Building Regulations Professional, Dept of the Environment*
W Lewis*
Dr M Molyneux*
LA Ragsdale, *Geo Wimpey Ltd*
LJ Rowlands, *Engineering Industry Users, Central Electricity Generating Board*
Dr EJ Smith, *Manufacturing Substitutes, Pilkington Bros Ltd*
RM Wagg, *Health and Safety Executive*
H Webster, *Users of Brakes and Gaskets, Automotive Products*

Description of asbestos

1 'Asbestos' is a generic term for the fibrous forms of several mineral silicates. These occur naturally in seams or veins, generally between about 1 and 20 millimetres (mm) in width in many igneous or metamorphic rocks and belong to one of two large groups of rock-forming minerals: the serpentines and the amphiboles.
We recognise the mineralogical complexities associated with the definition and identification of asbestos and asbestos fibre, but for the purposes of this report we concentrate on the fibre types with which people are most likely to come into contact as a result of their use in industry. The serpentine group contains the type of asbestos known as chrysotile ('white asbestos'), which is the only asbestiform member of this group of minerals and by far the commonest and commercially the most important type of asbestos. The amphibole group contains crocidolite ('blue asbestos'), amosite ('brown asbestos'), anthophyllite, actinolite and tremolite. Amosite is an acronym for Asbestos Mines of South Africa and is mineralogically known as cummingtonite – grunnerite asbestos. Tremolite may occur as a contaminant with chrysotile and with other minerals such as talc. Crocidolite, amosite and anthophyllite have all been exploited commercially, although anthophyllite is no longer in significant quantities.

2 The chemical composition of each type is different as shown in Table 1. Chrysotile fibres tend to be whitish in colour and of a smooth silky texture, while crocidolite fibres are usually blue and shorter, straighter and less silky than chrysotile. Amosite tends to be brown with fibres more brittle than either chrysotile or crocidolite. Colour is not, however, a reliable guide for identifying the type of asbestos used in a given product.

3 The term asbestos was first introduced by Plinius Secundus in AD 77 and it is a material that has been known to man for a long period of time. There is evidence for its use over 4000 years ago in Finland for strengthening clay pots, and Plutarch, writing in the first century AD, describes cloth woven from it which would not burn and so could be cleaned by immersion in fire. But it was not until the late nineteenth century that commercial exploitation began on a wide scale with the use of asbestos in the increasing number of industrial and commercial engines, later to be extended with the invention and wider use of the internal combustion engine and motor transport. Asbestos was also used on its own and with other substances for seals and insulation. In 1890 some 1000 tonnes were produced and today world annual production is of the order of six million tonnes which gives some indication of its use in technologically based society. Further history of the use of asbestos is given in Chapter 1.

4 The main properties which give asbestos its commercial value are incombustibility, strength and effectiveness as a reinforcing or binding agent when combined with other materials such as cement or plastic. The different types are also, in different degrees resistant to high termperatures, electric current and alkalis and efficient at absorbing sound. Only the amphibole fibres are resistant to acids.

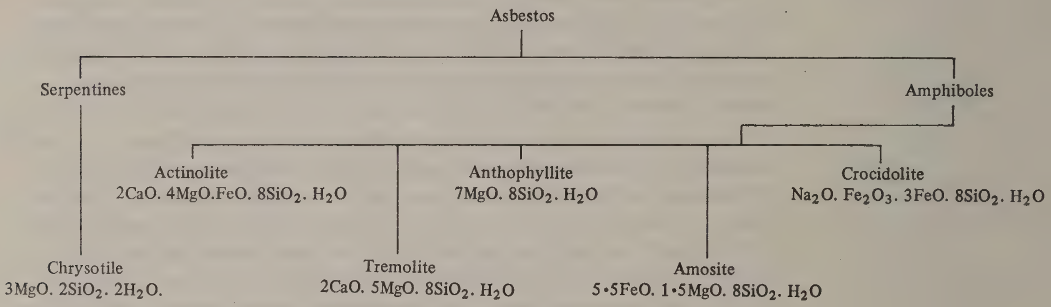
5 Chrysotile and crocidolite fibres, when broken down and separated, are often long enough to be spun and woven into cloth. The ability of asbestos fibres to split into finer fibre through suitable treatment is one of its most valuable and characteristic properties and when incorporated into cement or resin will produce substances which are light but extremely strong and durable. Additionally products manufactured from asbestos are thermally very stable and those using amphibole asbestos are chemically very resistant to acids and hence are particularly useful in high temperature and corrosive conditions.

6 No asbestos is mined in the United Kingdom. The largest world producer of asbestos fibre is believed to be the USSR, but the main sources for the asbestos imported into the UK are: Canada (Quebec and British Colombia) and Southern Africa (South Africa and Swaziland). Rhodesia was an important supplier until economic sanctions were imposed in 1966. Figures for asbestos production for 1978 are given in Table 2. The amount of asbestos imported into Britain as well as the use to which it is put are described in Chapter 1.

7 The raw asbestos used in Britain is mainly 'milled' or ground in the country of origin. The milling process separates the asbestos fibres from the useless non-fibrous material

that is extracted with it and also reduces the size of the fibres themselves. The fibres tend not only to break into shorter fibres but also, because of their crystalline structure, to split lengthwise into finer fibres or fibrils. Many of the individual fibres which result from this process are too small to see with the naked eye; their dimensions are usually stated in micrometres (millionths of a metre: μm) or even fractions of micrometres. Milled fibre is graded according to length and diameter by means of a machine incorporating a series of sieves of progressively finer mesh: a known quantity of the fibre to be tested is passed through the machine and the amount trapped by each sieve is measured. The grading system is complicated and, for amphibole asbestos, differs from one mine to another. What is important for the purpose of this report is that different grades of asbestos fibre contain different proportions of fibres in the respirable range (that is, fibres of a size and shape which permit them to reach the depths of the lung).

Table 1 Varieties of asbestos and their chemical composition


Asbestos
Serpentines
Amphiboles
Actinolite
$2CaO. 4MgO.FeO. 8SiO_2. H_2O$
Anthophyllite
$7MgO. 8SiO_2. H_2O$
Crocidolite
$Na_2O. Fe_2O_3. 3FeO. 8SiO_2. H_2O$
Chrysotile
$3MgO. 2SiO_2. 2H_2O.$
Tremolite
$2CaO. 5MgO. 8SiO_2. H_2O$
Amosite
$5{\cdot}5FeO. 1{\cdot}5MgO. 8SiO_2. H_2O$

Source: AA Hodgson, *Fibrous Silicates*, Royal Institute of Chemistry 1965

Table 2 World production of asbestos

Annual figures as at August 1978

	Tonnes
USSR	2 650 000
Canada	1 572 000
Southern Africa	783 000
Europe	353 000
China	250 000
USA	150 100
South Central America	130 000
Australia	80 000
Others	50 350
Total	6 018 450

Source: Asbestos Information Centre Ltd

Asbestos in the workplace

1

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Electron microscope photograph of crocidolite fibres

1 At the beginning of this century commercial ventures were exploring the particular attributes and uses to which asbestos could be put and developed. Techniques were found enabling the mineral to be spun and woven into yarn and cloth for insulation blankets, steam packing materials and jointings. Processes were developed for production of millboard for jointing purposes and fire resistant boards.

2 Production of asbestos goods was small until the 1914–18 war which brought about a considerable interest in asbestos-based materials and increased demand for asbestos products for insulation purposes in naval vessels. The introduction of the motor car at the turn of the century led to the development of friction clutches and brake linings which was enhanced after 1918 and rapidly increased the demand for asbestos fibre.

3 In the 1920s asbestos cement products were proving to be viable alternative materials for some building products, and this area of asbestos usage has continued to expand. With the increasing modern technology asbestos insulation materials were being more widely used, and its use for fire insulation boards in building ships and offices has increased significantly. It is estimated that some 3000 different products which contain asbestos are currently manufactured.

Importation of raw fibres and products

4 No asbestos is mined in Britain; all supplies being imported, mainly from Canada and South Africa. Table 3 gives the estimated consumption of the four main types of raw asbestos fibre in the United Kingdom in 1946, 1955, 1965 and 1975.

5 In 1975 chrysotile accounted for about 85% of the total imports of fibre, almost the whole of the remainder being composed of amosite. Expansion in imports of amosite since 1945 has been much greater than the expansion of imports of chrysotile so that, both in proportional and absolute terms, the amount of amphibole fibre being imported into the UK is considerably greater now than it was in 1945.

Table 3 Quantity of imports of asbestos (tonnes)

Year	*Amosite*	*Anthophyllite*	*Chrysotile*	*Crocidolite*	*Total*
1946	2 673	Not known	50 722	967	54 362
1955	12 308	Not known	122 965	6 822	142 095
1965	22 582	78	147 265	3 425	173 350
1975	19 219	225	119 741	Nil	139 185

Source: Asbestos Fibre Importers Committee, private communication

Table 4 Use of crocidolite

1893–1966	yarn, cloth, rope lagging, webbing, packings
1896–1965	Asbestos millboard, insulation mattresses
1925–1950	pre-formed thermal insulation
1935–1971	sprayed asbestos thermal and acoustic insulation
1925–1970	battery cases
1930–1940	welding electrodes
1930–1965	filtration materials
1950–1969	asbestos cement flat sheets, corrugated sheets, pipes, moulded products
1950–1969	asbestos cement pressure pipes
1960–1969	refractories, reinforced plastics

Source: Cape Industries Ltd: Submission to the Advisory Committee on Asbestos. Selected Written Evidence, p49

6 The most striking change in recent years is the cessation of raw crocidolite imports in 1970. Crocidolite has not been banned, but because of the very stringent control limits introduced in connection with the new Asbestos Regulations 1969, the UK asbestos processing industry has decided to stop using it. The decrease in the total figure (other than for crocidolite) between 1965 and 1975 may reflect short-term conditions (such as the economic condition of the construction industry) rather than a long-term trend.

7 In addition to raw asbestos, many products containing asbestos are also imported. It is impossible to give any estimate of the amount of asbestos imported in this way, because it is found in such widely differing proportions in such a wide variety of products.

Use of crocidolite

8 Although crocidolite or blue asbestos is no longer used in the manufacture of asbestos products in this country, it is still used in certain other countries, mainly in the manufacture of asbestos cement pressure pipes.

9 However before 1970, crocidolite was widely used here, for example in textiles, insulation mattresses, packings, as a filler where acid resistance was required and particularly in sprayed thermal and acoustic insulation. In its submission to the committee, one large manufacturer gave the list (Table 4) showing the appropriate years in which products were manufactured by them using crocidolite.[1]

10 Table 5 gives the estimated consumption of raw crocidolite for each of the main product groups since 1910. It was first used for insulation mattress manufacture in the UK in 1894.

11 It has been suggested to the committee that products containing blue asbestos are still being imported into the UK, notably crocidolite yarn for use in packings, but this is not thought to be happening on a significant scale. For some purposes for which crocidolite was formerly used, manufacturers have now switched to amosite, which shares crocidolite's good filtering and drainage characteristics, although it cannot be spun. We are informed by the Asbestos Cement Manufacturers Association that no asbestos cement now imported into this country contains crocidolite; according to Eternit (the sole importers of asbestos cement products), the last regular shipment containing it arrived in September 1975. However, judging by the figures given in Tables 4 and 5, there are still large amounts of home produced crocidolite-containing products in existence. Although imports of raw crocidolite ceased in 1970 substantial quantities of this material remain in insulation materials in buildings, ships, locomotives and railway carriages, in

Table 5 Production and consumption of crocidolite by product group
(Estimated UK consumption by principal product groups)

Year	*World production*	*UK imports*	*Textile products*	*Thermal insulation*	*Spray*	*Asbestos cement*	*Battery cases*	*Others*
1910	1 341	500	100	400	—	—	—	—
1920	2 801	750	100	650	—	—	—	—
1930	4 972	1 000	100	900	—	—	—	—
1940	8 075	2 655	127	300	907	—	1 288	33
1950	28 805	5 267	229	197	1 508	574	2 634	125
1960	83 659	4 006	117	64	272	2 130	1 423	—
1970	137 235	563	—	—	—	—	635	—
1975	164 727	Nil	—	—	—	—	—	—

Source: Cape Industries Ltd: Submission to Advisory Committee on Asbestos Selected Written Evidence, p57

Table 6 Asbestos fibre usage in the UK *(thousands of tonnes)*

	1970	*1973*	*1976*
1. Asbestos cement products for building (including (5))	52.5	55.6	42.9
2. Fire-resistant insultation boards	18.5	22.5	14.5
3. Other insulation products (including spray)	4.0	4.0	0.4
4. Floor tiles and coverings	20.5	16.2	15.8
5. Asbestos cement pipes (included under (1))		9.0	8.1
6. Friction materials	15.0	17.0	15.7
7. Jointings and packings	9.0	11.4	10.0
8. Textiles products not included in (6) and (7)	9.0	8.3	6.3
9. Fillers and reinforcements (felts, millboard paper, underseals, mastics, adhesives, etc)	21.5	25.7	28.4
10. Moulded plastics and battery cases	4.5	2.8	1.2
Totals	154.5	172.5	143.3

Source: Turner and Newall Ltd

Notes

The figures for 1970 are estimated and converted into tonnes (2 204.6 lb) from long tons (2 240 lb) to the nearest 500 tonnes.

The annual totals are not directly comparable with those in Table 3 because the asbestos fibre imported in a given year may not necessarily be used in that year.

cement products including pressure piping and in battery boxes. Most of these are likely to cause problems only when they are broken up or damaged so as to release fibres into the air. The risk of this is greatest with some types of insulation products and we have already suggested new methods to tighten control and lessen the health risks in these areas.[2]

Use of other types of asbestos fibres

12 The other types of raw asbestos which enter this country are put to a wide variety of uses, the recent trends in which are indicated in Table 6.

13 A summary of the uses of asbestos fibres in 1976 (Table 7) shows that asbestos cement products for building (32.8 %), fillers and reinforcements (22.0 %), floor tiles (12.2 %) and friction materials (12.1 %) consume a large proportion of imported chrysotile but there are many other uses. On the other hand the range of usage of amosite is very restricted, being dominated by the production of fire resistant boards (84.3 %) with the manufacture of pressure pipes (7.9 %) a poor second. Data about the trends in usage of chrysotile shows the manufacture of jointings and packings, friction materials, and fillers and reinforcements to have been the main areas of growth in recent years. The last sub-head mentioned, because of its scale, rate of growth and the variety of products manufactured (it includes felts, millboards, paper, filter pads, underseals, mastics, adhesives and coatings), is an area where much more information about dust levels and conditions of work is required.

14 It is not possible to give a complete quantified breakdown of fibre usage for years before 1970 because the necessary records are not available. But there is no doubt that in earlier years floor tiles would not have accounted for a significant proportion, and relatively more of the imported fibre would have been used in thermal and acoustic insulation products than in 1976.

15 The asbestos referred to in Table 8 is chrysotile (129200 tonnes in 1976). Amosite does however, predominate in fire-resistant insulation boards and other insulation products, and constitutes between a quarter and a half of the fibre used in moulded plastics and battery cases; it is also used to a small extent in asbestos cement. The very small quantity of anthophyllite that is imported goes into fillers and reinforcements, and into friction materials.

16 Three companies process nearly all of the raw asbestos in Britain: Turner & Newall Ltd, Cape Industries Ltd, and the BBA Group Ltd. Of these, Turner & Newall have made products across the whole range listed in Table 6, while Cape has specialised in friction materials, asbestos cement products and thermal and acoustic insulation, and the BBA Group has specialised in friction materials and textiles. Other large users include Eternit Building Products Ltd (formerly the Atlas Stone Company Ltd), which makes asbestos cement products and a small amount of insulation board. A description of the processes used, their applications and the measured concentrations of asbestos dust generated are given in Appendix A.

Table 7 Breakdown of usage of asbestos fibres in the United Kingdom in 1976[3] (*see Vol 2 Table 2a*)

	Chrysotile		*Amosite*		*Anthophyllite*		*Total*	
Usage	*Metric tonnes*	%	*Metric tonnes*	%	*Metric tonnes*	%	*Metric tonnes*	%
Asbestos cement for building	42 400	32.8	500	3.6	—	—	42 900	30.0
Asbestos cement for pipes	7 000	5.4	1 100	7.9	—	—	8 100	5.7
Fire resistant boards	2 700	2.1	11 800	84.3	—	—	14 500	10.1
Other insulation products	200	0.1	200	1.4	—	—	400	0.3
Jointings and packings	10 000	7.8	—	—	—	—	10 000	6.9
Friction materials	15 600	12.1	—	—	50	50	15 650	10.9
Other textile products	6 300	4.9	—	—	—	—	6 300	4.4
Floor tiles	15 800	12.2	—	—	—	—	15 800	11.0
Plastics and battery boxes	800	0.6	400	2.8	—	—	1 200	0.8
Fillers and reinforcements*	28 400	22.0	—	—	50	50	28 450	19.9
Totals	129 200	100.0	14 000	100.0	100	100.0	143 300	100.0

*including felts, millboards, paper, filter pads for beverages, underseals, mastics, adhesives, coatings, etc.

Table 8 Estimated usage of chrysotile asbestos in the United Kingdom from 1880–1976 (in metric tons)

	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	1973	1976
1. Asbestos cement—building uses	—	—	—	1 000	9 000	12 500	29 000	42 000	58 500	49 000	55 600	42 400
2. Asbestos cement—pressure and other pipes	—	—	—	—	—	300	4 000	12 000	10 000	8 000	7 800	7 000
3. Fire resistant insulation board	—	—	—	—	—	—	—	500	1 000	4 000	3 000	2 700
4. Other insulation products incl: spray	10	500	2 000	2 600	3 400	3 000	5 000	6 000	5 000	1 700	1 300	200
5. Jointings and packings	60	400	1 400	2 000	3 200	3 200	6 200	6 500	7000	9 000	11 400	10 000
6. Friction materials	—	—	—	100	1 000	1 500	3 000	6 000	10 000	17 000	18 500	15 600
7. Textile products not in (5) and (6)	10	100	600	1 000	1 500	2 000	4 000	6 000	7 000	7 300	6 000	6 300
8. Floor tiles and flooring	—	—	—	50	300	400	1 000	5 500	12 500	19 000	16 200	15 800
9. Moulded plastics and battery boxes	—	—	—	—	—	—	300	2 000	2 000	3 000	2 200	800
10. Fillers and reinforced cements (felts, millboard, paper, underseals, etc)	—	—	—	50	1 600	2 100	9 500	16 500	18 000	21 000	25 300	28 400
Total	80	1 000	4 000	6 800	20 000	25 000	62 000	103 000	131 000	139 000	148 000	129 200
Approx chrysotile tonnage imported	80	1 000	4 600	6 800	25 000	22 000	88 000	111 000	142 000	132 500	171 000	130 000

Sources: Board of Trade Census of Production Returns from 1924: Ministry of Works monthly statistics of Building Materials; TBA production statistics from 1933; submissions to the Monopolies Commission; and recollection of long-service officials in some of the principal companies.

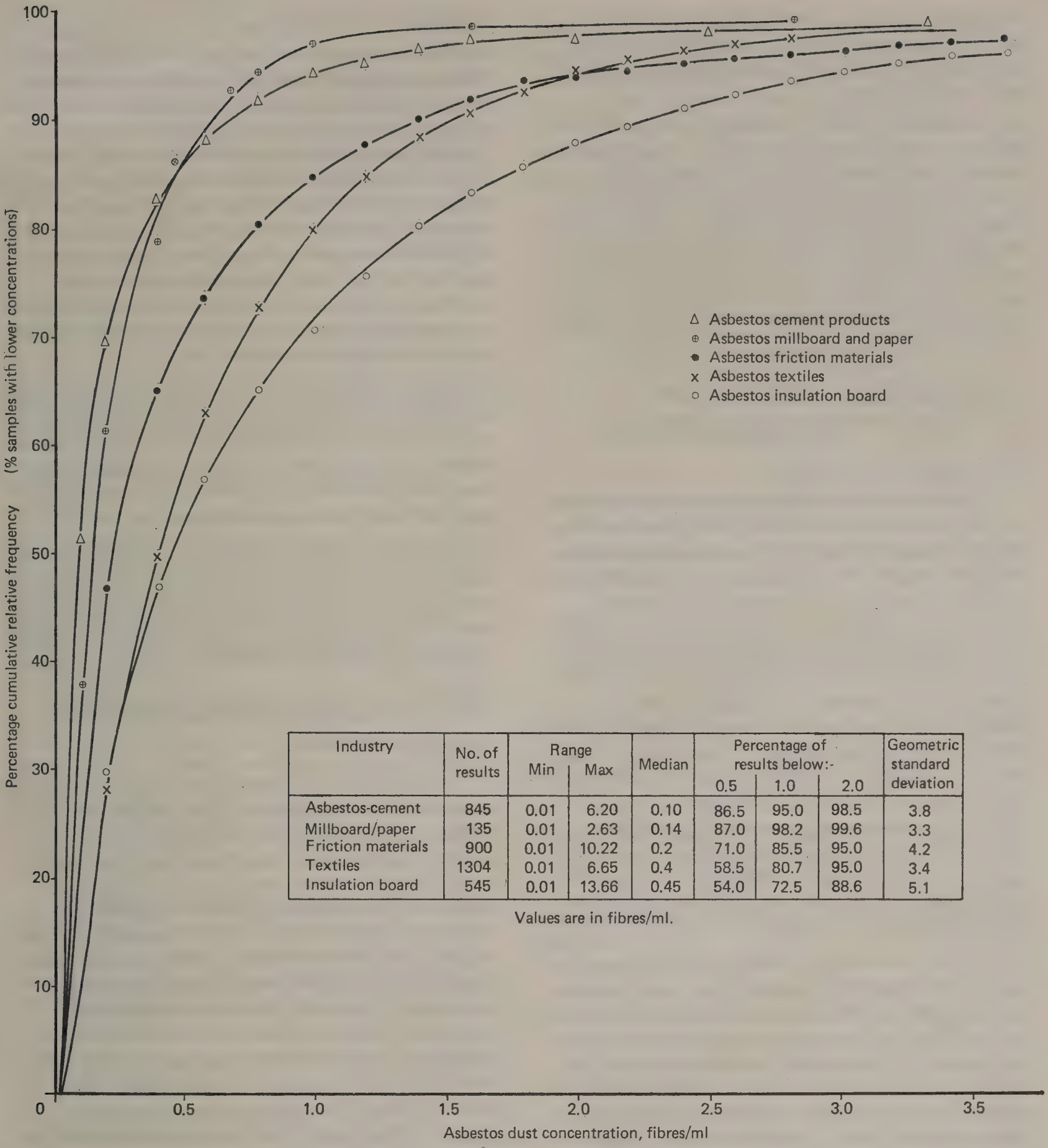
A comparison of dust levels between five industries

17 The Factory Inspectorate have collected a considerable amount of occupational hygiene data based on personal sampling at operations involving the manufacture of asbestos-based products which include asbestos cement products; asbestos insulation board; asbestos friction materials; asbestos textiles; asbestos millboard/paper.

The results of their measurements are summarised in graphical form in fig 1. This figure shows that among these five product groups the lowest median level of exposure to asbestos dust over the five year period 1972–78 occurred in the asbestos cement industry, the smallest variation in exposure levels (indicated by the geometric standard deviations) being found in the production of millboard, paper and asbestos textiles. The highest average exposures and widest variation occurred in the insulation board industry.

Methods of reducing concentration of asbestos dust

18 Concentrations of dust in the atmosphere at the workplace may be reduced by suppression at source or by control of dust escaping into the atmosphere in which



Industry	No. of results	Range Min	Range Max	Median	Percentage of results below:- 0.5	1.0	2.0	Geometric standard deviation
Asbestos-cement	845	0.01	6.20	0.10	86.5	95.0	98.5	3.8
Millboard/paper	135	0.01	2.63	0.14	87.0	98.2	99.6	3.3
Friction materials	900	0.01	10.22	0.2	71.0	85.5	95.0	4.2
Textiles	1304	0.01	6.65	0.4	58.5	80.7	95.0	3.4
Insulation board	545	0.01	13.66	0.45	54.0	72.5	88.6	5.1

Values are in fibres/ml.

Fig 1 Distribution of asbestos dust exposure levels in different manufacturing industries (*Based on 4-hour personal sampling data obtained in the period Nov* 1972–*Feb* 1978)

the work takes place. For example, the use of wet methods of production, where practicable, can give substantial reductions in the dust produced when they are correctly applied.

19 Where dust cannot be eliminated it is essential to minimise its dispersion through engineering control such as local exhaust ventilation and air filtration. Where this is not practicable, it is a requirement of the Asbestos Regulations 1969 that workers should be provided with protective equipment, including protective clothing and approved respiratory protective equipment. However, as the range and effectiveness of these control methods were important considerations in our review, Appendix B gives a more full description of their operation.

Transport of asbestos and asbestos-containing products

RAW ASBESTOS FIBRE

20 Modern cargo handling methods have reduced the risk from asbestos fibre in docks. Most raw asbestos is packed in impermeable plastic bags (although some jute and paper bags are still in use, mainly in shipments from the USSR). These bags are either packed in freight containers (sometimes on pallets inside the containers for ease of unloading), or else on pallets with a 'tea-cosy' plastic cover over the whole pallet. All asbestos from Canada is now containerised. This is also true of shipments from South African ports, but Swaziland and those South African mines which ship through Mozambique still have to use pallets as the port of Maputo cannot yet handle containers.

21 The principal British ports handling raw asbestos fibre are Liverpool, Manchester and London, and of these Liverpool and London insist that the fibre is containerised. Manchester, Glasgow and Southampton apparently accept palletised fibre.

22 The imported fibre may remain in containers or on pallets until it reaches the factory where it will enter the manufacturing process. Alternatively, shipments may be split up at the warehouse or at some intermediate stage and the sacks of raw asbestos transferred to lorries for distribution to a number of factories. Measurements of asbestos dust concentrations by personal sampling were taken at the unloading in September 1976 of a ship carrying mixed cargo, including asbestos which was not containerised. Fifty-eight measurements were obtained, the sampling time generally being between 15 and 35 minutes; 29 gave dust counts of below 0.01 fibres/ml; 27 gave dust counts between 0.01 fibres/ml and 0.1 fibres/ml; and 2 gave higher counts of 0.28 f/ml and 0.42 f/ml.

23 One problem which can arise at ports is that, even in ships not carrying asbestos for unloading in Britain, the hold may be contaminated with asbestos fibres from a cargo previously unloaded elsewhere. On at least one occasion a vessel with a cargo of asbestos has been returned to the port of loading because bags had burst in transit and contaminated the hold with raw fibre.

ASBESTOS PRODUCTS

24 Whether a product containing asbestos is likely to constitute a potential health risk during transportation depends on the friability of the product, the nature of the packaging (if any) and the amount of rough treatment to which it is subjected. Because of the variability of these factors, it is impossible to give any general figures for concentrations of dust. The unloading of asbestos insulation board has, however, been found to generate high dust concentrations at any rate in the short term: cut pieces of board have been found to give rise to between 5 and 15 fibres/ml, and manufacturers' standard-size sheets have given rise to between 1 and 5 fibres/ml, for a sampling time of ½–1 hour.

25 Aware of the problems of loose dust during handling in transportations as well as use, some companies have now introduced a sealing process whereby each sheet of insulation board is coated after initial maturing with a water-based dust seal. This reduces the amount of dust given off during handling at all stages.

26 A few other products containing asbestos have been found to give off an undesirable amount of dust during transit if they are jostled together: for example, electrical insulation components made from high-density asbestos cement, and resin-impregnated paper or felt products.

Removal, dismantling, stripping and demolition

27 It is mainly in the dismantling of plant, ship-breaking and the demolition of large buildings that the removal of products containing asbestos presents dust problems. Dust levels can be very high, and are usually harder to control than in manufacturing processes for reasons which, while fairly obvious, are worth emphasising. Factory processes are static, so that it is possible to apply long-term dust control measures such as enclosure and effective exhaust ventilation equipment; the dust and other asbestos waste from the processes can also be trapped easily and contained and disposed of safely. Demolition and plant dismantling operations, including scrap reclamation, however, are seldom static; dust control is relatively more expensive and the safe collection of the waste generated presents more serious problems. These are some of the reasons why there is a possibility of serious occupational exposure to asbestos dust in these types of activity, particularly dismantling and ship-breaking, and why it was decided to devote the First Report to recommending new legal controls in these industries. The various operations involved in this work are described in Appendix C.

28 The committee noted that two sub-committees of the Joint Advisory Committee on Safety and Health in the Construction Industries have considered some of the problems involved in preventing exposure to asbestos during demolition work. The first sub-committee was set up to '*examine the ways in which the construction industry can control the exposure of work people to the dangers of*

asbestos dust', and in its report[5] published in 1974, referred to demolition processes involving the removal of asbestos lagging. The second, which includes as well as representatives of the National Federation of Demolition Contractors, representatives also from the TUC, the British Scrap Federation and the Demolition Industry Conciliation Board, was set up to consider the dangers inherent in demolition work with particular regard to the safety of workers and dangers to the public. This sub-committee has now also published a report[6] and among the recommendations is one for research into risks arising from asbestos on demolition sites and into controls for asbestos dust thereon. Another recommendation is for a checklist on the characteristics of asbestos to be compiled and published by a suitable body. The list would provide guidance to supervisors on the action and precautions to be taken when asbestos is present on demolition sites.

Size of the asbestos workforce

29 We have not been able to determine the exact numbers employed in the asbestos industry because of the obvious difficulty of defining 'asbestos industry' and because the activities and occupations for which employment statistics are gathered do not correlate closely with those in which there is contact with asbestos. Certainly, there are so many firms which may occasionally use asbestos or products containing it that to give exact figures for everyone who may be occupationally exposed would be impossible. We have however, gathered some figures from three separate sources which give some indication of the number of asbestos workers in Britain; by 'asbestos worker' we mean any worker employed (at least occasionally) in any place which attracts the Asbestos Regulations 1969.

30 We have been told by the Asbestos Information Centre Ltd (AIC) that in 1978 its associated companies (including the three major asbestos manufacturers as members and twelve other companies as associated members) employed between them 21514 asbestos workers, as follows:

Automotive products	9 735
Construction materials	5 645
Asbestos textiles	3 825
Sealing materials (eg packings, gaskets)	1 735
Others (eg reinforced plastics)	574
Total	21 514

The number of asbestos workers employed in the manufacture and processing of sealants, floor coverings and paints is more difficult to assess but it is estimated that there are probably a further 2000 people engaged in these three parts of the industry, with about 1300 in floor coverings.

31 In addition the Thermal Insulation Contractors Association tell us that in 1978 member companies employed 8000 operatives, some of whom could come under the definition of asbestos workers at some time, while we are told that firms on the Demolition and Dismantling Industry Register employed in 1978 about 9000 operatives. Again, some of those would probably be classed as asbestos workers. The British Floor Covering Manufacturers Association has advised us that there were about 4000 employees in member companies in 1978 with about 1300 engaged in work with asbestos.

32 The Employment Medical Advisory Services (EMAS) have since 1971 been engaged in a study of asbestos workers and by November 1977, they had examined some 24000 workers, of whom 18700 were thought to be still employed in work subject to the Asbestos Regulations. They add that it is possible there may well be some workers in the country about whom they have not been notified and who therefore have not yet been examined, but EMAS think it unlikely that there are more than about 2000 workers in this category - and probably considerably less.

33 We expect that the true total number of asbestos workers in this country is constantly changing as jobs are lost and created and methods of work change. Nevertheless it appears that the number is unlikely to exceed 25000 at any one time.

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1 Advisory Committee on Asbestos: *Selected Written Evidence Submitted to the Advisory Committee on Asbestos* 1976–77, (SWE), Health and Safety Executive, 1977; p49.

2 ACA: *Work on Thermal and Acoustic Insulation and Sprayed Coatings*, HSC, 1978; pp13–15.

3 Evidence submitted to the Advisory Committee on Asbestos. United Kingdom Breakdown of Asbestos Fibre Usage, 1976.

4 ACA: Ibid, 2 above.

5 Sub-Committee of the Joint Advisory Committee on Safety and Health in the Construction Industries: *Precautions in the Use of Asbestos in the Construction Industry*, HSC, 1974.

6 Sub-committee of the Joint Advisory Committee on Safety and Health in the Construction Industries: *Safety in Demolition Work*, HSC, 1979.

Appendix A

The production and use of asbestos in the UK

A1 This Appendix describes the uses to which raw asbestos is put in the UK, manufacturing processes involving products containing asbestos and the handling and use of asbestos and asbestos-based products during subsequent operations. Manufacturing processes and uses are listed in descending order of volume of recent annual production (see Table A1 and Table 6 reproducing the usage in ordering 1976 for ease of reference).

A2 Wherever possible, information is given of the results of measurements of dust concentrations both by HM Factory Inspectorate (HMFI) and by industry, to provide an indication of the relative risk associated with each activity. In most cases, the dust concentration data are based on a 4 hour personal sampling period. The dust measurements are all derived from samples taken since 1972 and therefore do not include measurements for sprayed applications of asbestos. The results may not be fully representative because they are based on a small number of factories and sites and there are problems of measurement error, which have yet to be resolved. However it is HMFI's opinion that the results are sufficiently consistent to allow comparison between the different operations.

PRELIMINARY PROCESSING

A3 Raw asbestos has to undergo a grinding or milling operation before it is suitable for industrial use. In the past this operation was sometimes carried out at the premises of the industrial users in the UK, but now it is mainly carried out at the mine in the country of origin.

A4 A process which is obviously common to all users of raw asbestos is the opening of the bags containing the raw fibres. Usually this takes place in a gallery above the first stage of the manufacturing process, where the bags are slit with a knife by hand and the fibre tipped directly into a receptacle fitted with exhaust ventilation. Since the fibre is tightly packed in the bag, it is usually necessary for the operative to poke it out with a stick. Typically this now gives rise to dust concentrations below 2 fibres per millilitre (fibre/ml). Higher figures were, however, usual in some plants during the 1960's often before suitable exhaust ventilation was installed[1]. In at least one firm respiratory protective equipment is regularly worn while bags of raw fibre are emptied into the mixing unit. Clearly, exposure to respirable dust will be less if the operation is carried out automatically and a specially designed enclosed machine has been developed and used experimentally by one manufacturer.

Table A1 Asbestos fibre usage in the UK in 1976 in descending order by volume

	Thousands of tonnes
1 Asbestos cement products for building	42.9
2 Fillers and reinforcements (felts, millboard paper, underseals, mastic, adhesives, paints etc)	28.4
3 Floor tiles and coverings	15.8
4 Friction materials	15.7
5 Fire resistant insulation boards	14.5
(other insulation products including spray)	0.4
6 Jointings and packings	10.0
7 Asbestos cement pipes	8.1
8 Textile products not included in 6 and 7	6.3
9 Moulded plastics and battery cases	1.2
Total	143.3

Source: Turner and Newall Limited

ASBESTOS CEMENT

A5 Basically asbestos cement is cement reinforced with asbestos fibre (approximately 10% to 15% of the total by weight). Although it is a non-combustible material as specified by BS 476: Part 4: it will not withstand exposure to direct flame or temperature over 260°C. There are two main categories of products in this field: building materials and pressure and sewerage pipes. Some asbestos cement manufacturers also make such items as electrical insulation products, millboard and paper, and thermal and acoustic materials. These products, however, are not normally classed as 'asbestos cement' and are dealt with under separate headings.

A6 The asbestos cement manufacturing process, based on that invented in 1900 by Ludwig Hatschek, is similar to that used in making paper. A sheet is built up to the desired thickness by a lamination process involving successive applications of a thin wet film of asbestos and cement particles. The sheet is moulded while still pliable into the required shape, either by mechanical means or by hand. When set, the product is trimmed and finished and left to mature for a period of weeks.

ASBESTOS CEMENT BUILDING PRODUCTS

A7 Of the approximately 143 300 tonnes of asbestos imported into Britain in 1976, about 42 900 tonnes were used in the manufacture of asbestos cement building products such as roofing and cladding sheets (plain or corrugated) and tiles, exhaust ventilation ducting, cisterns for domestic cold water storage, and paving tiles; a small quantity of high-density asbestos cement is also made for specialised thermal and electrical insulation purposes. Table A2 gives the estimated total (by weight) of asbestos cement building products manufactured in and imported into this country in 1975.

A8 Asbestos cement imports are all from the Eternit Company in Belgium, which does not now use crocidolite in the goods for export to Britain.

A9 The asbestos dust levels generated in asbestos cement manufacture are generally low in comparison

Table A2 Asbestos cement building products in the UK

(1975 in 000's tonnes)	*UK manufactured home deliveries*	*Imported home deliveries*	*Total home deliveries*	*UK manufactured exports*
Corrugated sheeting and accessories	256	1	257 (71%)	30
Flat sheeting	30	10	40 (11%)	15
Rainwater goods	7	—	7 (2%)	—
Other products	27	29	56 (16%)	5
Totals	320*	40	360 (100%)	50

*Compares with 527 in 1973 (the 'peak' year)

Note: Source: Asbestos Cement Manufacturers' Association, in evidence to the Advisory Committee (Selected Written Evidence p2).

with most other manufacturing processes involving asbestos with average dust counts of around 1 fibre/ml.

A10 Most products containing asbestos for use in the construction industry do not undergo any further manufacturing operation between leaving the factory and being delivered to the contractor who uses them in construction or civil engineering operations. However, some asbestos cement products do undergo an intermediate stage during which they are cut, drilled or otherwise processed by specialist companies to meet special requirements of the contractor before reaching him. The advantage of this for the contractor is that the relevant cutting and drilling operations do not have to be carried out on site. The industry's approximate estimate of the annual amount of asbestos based building material that is pre-cut or otherwise processed before it reaches the site is 10% of the annual total production of such material. A small but growing number of companies (about 31 in 1978) provide this processing service as a subsidiary activity to their main function as merchant or distributor specialist contractor or general fabricator. Much of the work in this business tends to be 'one-off' jobs of short duration.

A11 At a large asbestos cement factory, most of the workers are likely to come into contact with the product only when it is at the wet stage of manufacture, and where, therefore, the dust risk is very low. In contrast, at the workshops where the processing service is provided although there is normally no raw fibre as such, there is a likelihood of contact with dust from sawing and drilling operations unless proper precautions are taken, involving the provision of exhaust ventilation and the use of respiratory protective equipment. An analysis by industry of 171 samples taken in one of these workshops during a period of 12 months has shown that 93% of the samples gave readings below 2 fibre/ml; and of the remaining 7% all were below 5 fibres/ml. Where the hygiene standard was exceeded most of the readings were based on 10 minute samples and therefore probably give a higher reading than would result from tests on a time weighted 4 hour basis; the other high readings were found to be due to minor production problems which were soon corrected.

INDUSTRIAL AND COMMERCIAL APPLICATION

A12 Asbestos cement products for use in construction can be divided into five categories:

(a) Corrugated sheeting: roofing and vertical cladding for farm buildings, factories, warehouses, garages, civil engineering work, riverbank supports, cooling towers;

(b) accessories for corrugated sheeting: moulded items such as ridge cappings, barge boards and eaves fillers for roofs;

(c) flat sheeting: partitioning, external cladding, door facings, roof tiles, infill panels, fire surrounds;

(d) rainwater goods: gutters, drain pipes;

(e) other products: flue pipes, garden furniture, cisterns, decking tiles.

The magnitude of these categories, in terms of the asbestos cement tonnage in each is set out in the section on manufacture in Table A2. Corrugated sheeting and accessories accounted for 71% by weight of total home deliveries of asbestos cement products (excluding pipes) in 1975.

A13 The extent to which the application or installation of any of these products presents a health hazard to the operative depends very much on the amount of cutting, sawing or drilling that is involved, whether hand tools or power tools are used, whether the work is damped, and whether it takes place in the open air or a confined space. The particular circumstances of each construction site vary so that it is difficult to give typical atmospheric dust concentrations. The following figures, which have been found for various operations involving asbestos cement should be taken only as a rough guide.

A14 Asbestos cement manufacturers have in recent years aimed to reduce the amount of on-site cutting and drilling that is necessary by increasing the range of sheet sizes available. This has been more successful with corrugated sheets (which usually now require only mitring and drilling after they leave the factory) than with flat sheets (which still often require further cutting on site or by specialist cutter merchants).

High-density asbestos cement for electrical and thermal insulation components

A15 High-density asbestos cement is used in the manufacture of a wide variety of products. For thermal

Table A3 Concentrations of asbestos dust measured during operations on asbestos cement

Operation	*fibres/ml*
Machine drilling	less than 2
Hand sawing	2–4
Machine sawing without effective local exhaust ventilation	
(a) jig saw	2–10
(b) circular saw	10–20
Machine sawing with effective exhaust ventilation	less than 2

insulation and fire and chemical resistance it is found, for example, in induction furnaces, bench tops and fume cupboard linings. The main electrical use is in arc-shield applications in control and switch gear. The material is supplied by the manufacturer either in sheet form or already machined.

A16 Handling sheets of one variety of high-density asbestos cement has been found to give rise to dust counts of about 2.5 to 3 fibres/ml, but attempts are being made to reduce the hazard by improving the sanded finish of the product with a brush treatment. In one instance the manufacturer packs his machined components in plastic bags to avoid polluting storage bins with asbestos dust.

Fillers and reinforcements

A17 This category, accounting for 28 450 tonnes of asbestos in 1976, is second only to asbestos cement building products in magnitude of tonnage used. The main products within the category are asbestos paper and millboard. These are used in the manufacture of products as diverse as roofing felts, clutch facings and gaskets. Although the manufacture of asbestos paper and millboard is in the hands of the main asbestos companies, much of the further processing is carried out by other companies.

A18 The method of manufacture for asbestos paper and millboard is, as the name implies, the same paper-making process as is used in making asbestos cement and insulation board although the asbestos content of the paper and millboard is higher (approaching 100%). Asbestos paper is usually sold in roll form. Millboard is built up by winding layers of thin sheet on to a cylinder until the desired thickness is reached; the sheet is then cut off, dried in a hot air oven and cut to size.

A19 Dust levels associated with millboard and paper manufacture are found by industry to be mostly in the range 0.5–1.2 fibres/ml. Wet processes usually generate levels below 1.0 fibre/ml whereas dry cutting and handling produced a wider distribution of dust concentrations.

Roofing felt and damp-proof courses

A20 Roofing felt is often made of asbestos paper impregnated with bitumen and coated with fine sand and chalk, etc. For damp-proof courses, this bitumen-impregnated felt is further laminated to metallic sheeting. On-site operations with these products are unlikely to generate respirable asbestos dust.

Felt, paper or cloth for electricial equipment

A21 Various products made of asbestos felt, paper or cloth and impregnated with resins are used in the manufacture of switch gear, generators and transformers. The amount of machining carried out by the customer has declined, since it is now usual for the products to be supplied in a form where little or no further machining is required.

Paints containing asbestos

A22 Asbestos fibres are added to paint to give it not only the ability to produce various textured finishes but also strength, ease of application, adhesion and opaqueness. The asbestos content is around 4% by weight.

A23 One of the more common products on the market is Artex compound which is manufactured from water soluble resins combined with fillers and pigments formulated to give adhesion and resilience. It can be applied by brush trowel in liquid or paste form. A fungicide is incorporated to obviate the risk of mould growth. It is, in its applied form, non-combustible and has a Class O. surface spread of flame rating.

A24 Of the two forms of application the wet process is the more commonly used and has been widely employed over the last 20 years. The paste is mainly used as an economical decorative textured finish to form a crack resistant surface to a system of ceiling construction; it also has the advantage that subsequent applications of paint can easily be applied to it. It is usually applied by trowel and 'combed' to produce the desired design.

A25 In practice paints containing asbestos fibres are applied to many surfaces particularly plaster/plasterboard surfaces, concrete and sand/cement rendering. We have been unable to obtain accurate information on the full extent of use but application does appear to be very wide and in large quantities particularly in housing. As the paint has a very low asbestos fibre content which is effectively sealed 'in situ', particularly with each further application of paint, the risk is minimal. There is however a small potential risk as despite the low asbestos fibre content, fibres could be released when the need to rub down the paintwork arises – for example, before recovering with new paint.

Plastic sheet and tile flooring

A26 Many plastic flooring and floor covering materials contain asbestos and in 1976 some 15 800 tonnes of the raw fibre imported into the UK were used in their manufacture. Total production of these materials in the UK in 1975 amounted to about 50 million square metres. Well known types of material in this category are thermoplastic tiles (BS 2592:1973) and PVC (vinyl) asbestos flooring in tile form (BS 3260:1969). Both tiles are made from a blended composition of a thermoplastic binder, asbestos fibre, fillers and pigments. The binder for thermoplastic tiles consists of mineral asphalt and/or thermoplastic resins such as those obtained from the distillation of coal or oil. The binder for PVC (vinyl) asbestos tiles consists substantially of a vinyl chloride polymer or copolymer. Asbestos fibres contribute to the properties of the dough mix that enable an effective production process, and also largely account for the transverse strength of the finished tiles and for other properties. The asbestos content of both types may be up to 22% of the total weight; and only short chrysotile asbestos fibres are used.

A27 The tiles are usually fixed by solvent bitumen adhesives to a suitable sub-floor and are extensively used in dwellings as well as in public buildings such as schools and hospitals. Damaged or worn tiles can be relatively easily replaced.

A28 BS 3261:1973 permits the use of asbestos in flexible PVC flooring: most of the less flexible materials (mainly tiles) to BS 3261:1973 Part I contain asbestos, while the flexible tile and sheeting materials rarely do so.

A29 Some PVC sheet and other PVC floorings not covered by BS specification have a backing consisting of asbestos and a binding material:

> PVC sheet floor covering is produced principally for the home decor market. The top two layers of some of the products consist largely of plasticised PVC and contain no asbestos; these are backed with asbestos fibres and binders. The asbestos backing acts as a carrier sheet during the continuous high speed production process. The UK sales of these materials are believed to be of the order of several million square metres per annum. PVC sheet flooring has been very widely used in existing dwellings, laid mainly in kitchens, bathrooms and hallways over the existing flooring. In some cases the floor covering is fixed with adhesive but usually it is laid loose or fixed at the edges only. Incorrect laying, particularly on unsuitable floors, can lead to excessive wear and 'local' damage to the floor finish.
>
> PVC flooring is imported and has a backing of resin asbestos composition, under a thick top (wear) layer. The material is usually installed at the time of construction. The extent of its use in the UK is limited.

A30 One of the principal manufacturers of plastic sheet and tile flooring informed the committee that atmospheric fibre concentrations during manufacture are generally 0.2 fibres/ml or less except on the mixer platform next to the internal mixer, where a count of 0.9 fibres/ml has been recorded. These levels are consistent with those recorded by the Factory Inspectorate.

A31 In floor coverings the asbestos is part of the main filler content and is dispersed throughout the full thickness of the material. Some PVC floorings have what is described as a backing of 'latex-asbestos'. This is a synthetic rubber/asbestos mix, calendered to form a paper felt. From these products fibres might be released during the laying process, as a result of attrition between the backing and the floor surface, upon damage to or destruction of the PVC top layer of the flooring or when the flooring is removed. Typical measurements of dust concentration during laying of flexible floor coverings have been below 0.2 fibres/ml over 4 hours. Dust generated by cutting tiles is minimal and, from analysis, is shown to be nearly all limestone – the other major non-polymeric product in flooring.

Friction materials

A32 In 1976 friction materials accounted for about 15 650 tonnes of raw asbestos. Brakes and clutches in road vehicles of nearly all kinds contain asbestos in proportions ranging from 30% to 70% and there are also many industrial uses, such as in lifts and other machinery. Some types of railway rolling stock (eg London Underground trains) also use brake blocks containing asbestos, though in a smaller proportion.

A33 Brake linings may be of woven or moulded construction. Woven linings are made from special types of asbestos cloth impregnated with liquid resins, dried and thereafter, cut to size, shaped, baked and finally drilled and ground to finished dimensions. Moulded linings involve essentially a mixture of fibre, resins and/or rubber and modifying agents, which is compressed into sheet form, cut, shaped, baked and finished. The details vary, but there are two basic methods: an older dry mix method and a more modern 'wet' moulding method. Disc brake pads are made from compacts of dry mixtures of asbestos fibres, resins and modifiers, which are placed upon metal back plates, hot cured under pressure, baked and machined or ground to finished dimensions.

A34 Woven clutch facings are made by impregnating special types of asbestos cloth with liquid resin, followed by drying, baking and machining and grinding to size. Yarn wound facings are made by impregnating asbestos yarn or braid with resins, winding the resulting substance into discs, drying, baking, and machining and grinding to finished dimensions. Clutch facings are made in a similar way to moulded brake linings or else from asbestos millboard.

A35 Examples of dust levels found at a plant using the 'wet method' of brake lining manufacture from 1968 to the mid-1970's average concentrations below 2.0 fibres/ml, with higher counts said to be due to short sampling times, to exceptional circumstances or to the fact that some tests were carried out before new exhaust ventilation equipment was installed.

A36 An unusual example of a friction product containing asbestos is the nosing of stairs. The composition of this product is very similar to that of a moulded brake lining, and (as its name implies) its function is to give a non-slip surface to the edges of stair-treads. However, Ferodo has discontinued this use of asbestos because high dust levels were found to arise during on-site cutting and fitting. For example, if this material is cut with abrasive wheels or sanded to achieve a smoother surface, dust levels greater than 2 fibres/ml can be generated.

Insulation board

A37 In 1976, fire resistant insulation board accounted for 14 500 tonnes of asbestos fibre in Britain, of which 11 800 tonnes were amosite. They are made by a broadly similar process to asbestos cement products, but their asbestos content is much higher: 25% to 40%. As to dust levels during manufacture, two-monthly monitoring at one firm yielded readings of between

1 and 2 fibres/ml, with occasional counts of 4 fibres/ml during treatment of raw fibre, when respirators are worn. While at the wet processing stage the majority of measurements were below 2 fibres/ml, 12% were above this figure, some rising to about 6 fibres/ml. The range and distribution of results was wider at the cutting and machining stage. A slightly higher proportion were above 2 fibres/ml and again some rising towards 6 fibres/ml. Dust respirators are frequently necessary at operations involving the cutting, machining and handling of boards if the dust cannot be controlled by exhaust ventilation.

A38 One company has advised us that their boards are used approximately as follows:

Ceilings	19%
Fire protection (partitions and structural steelwork)	20%
Fire protection (linings)	33%
Fire protection (miscellaneous)	10%
Other	18%

In addition, asbestos paper is incorporated for insulation or flame-retardant purposes in various building products in steel composite wall and roof cladding, as a facing to combustible boards and in flame-resistant decorative laminates.

A39 A major use of asbestos insulation boards is for partitions and suspended ceilings that are required to provide a fire barrier or to protect structural steelwork. For partitions, building regulations require compartments (division walls), separating walls (party walls) and structures enclosing protected shafts to be fire resistant. In the case of ceilings, a floor structure may be required to have a fire resistance depending on the occupancy, height, floor area and capacity of the building. If the floor structure itself does not have the necessary fire resistance it may achieve the standard by means of a suspended ceiling.

A40 Other important uses of asbestos insulation board are for the fire protection of building elements and for ducting. The fire protection of structural elements and particularly of steelwork, is an important use for asbestos insulation board, but no statistics on the extent of this use are available. Although the casings are generally assembled on site, not always prefabricated, the cutting of the boards to specified sizes for this use is usually carried out by cutting specialists in workshops having dust control facilities. Asbestos in the boards helps to give the fire protection its heat resistance, strength and stability.

A41 Asbestos insulation boards are used for ducts for piped and wired services, for fire resisting enclosures to protected shafts, and for ventilation. The ductwork may be made on site, or prefabricated. No statistics for the extent of use are availble. Asbsetos here helps to provide resistance to fire, thermal insulation (especially important for ductwork delivering heated air) and acoustic insulation, as well as an acceptable degree of strength and standard of appearance.

Table A4 Concentrations of asbestos dust measured during operations on asbestos insulating boards

Operation	*fibres/ml*
Drilling vertical structures, eg column casing	2–5
Drilling overhead, eg suspended ceiling	4–10
Sanding and surforming	6–20
Scribing and breaking	1–5
Hand sawing	5–12
Machine sawing without effective local exhaust ventilation	
jig saw	5–20
circular saw	20 upwards

A42 Since the asbestos content of insulating boards is greater than that of asbestos cement and since the fibres are less tightly bound, the potential risks to operatives during installation are correspondingly higher. Once again, it is misleading to talk of typical dust concentrations, but the following concentrations have been found in association with various operations.

A43 The unloading of stacked boards involving rubbing together of adjacent surfaces, has been found to produce relatively high dust concentrations. Sampling times of ½–1 hour have indicated fibre levels between 1 and 5 fibres/ml during unloading of standard sheets, and between 5 and 15 fibres/ml during unloading of cut pieces.

Some companies have now introduced a sealing process whereby each board is coated with a water-based seal. This surface treatment reduces the amount of dust generated during handling, but cannot be expected to reduce appreciably that produced by cutting, drilling or any other treatment that exposes fresh surfaces.

Asbestos insulation boards are tending to be replaced by products containing other fibres so that the risk to users should be consequently reduced.

Other insulation products (*including spray*)

A44 A second form of asbestos insulation, more convenient for application to surfaces which are uneven or hard to get at, can be applied by a spray. In the past it has been applied extensively to structural steelwork, particularly in factories, to increase its fire resistance. It has also been used for sound absorption purposes especially in schools, hospitals and swimming pools. But the application process is relatively risky for the operative, and the sprayed asbestos tends to deteriorate fairly quickly and give off fibres into the surrounding air unless it is sealed or coated. There is very limited information on this process before pre-damping was introduced and such figures that exist would suggest that levels in excess of 100 fibres/ml existed in the spraying zone. For these reasons the process has been almost entirely discontinued and our First Report[3] recommended that it should be an offence to make a new sprayed application of materials containing asbestos.

A45 Asbestos lagging for thermal insulation has in the past taken the form of rigid pipe sections or slabs as well as sprayed coatings. The asbestos content of such sprays could approach 100%, and crocidolite was widely used in them before its importation was discontinued. As Table A1 above and Table 6 in Chapter 1 show, only about 400 tonnes of fibre were used in 1976 to make insulation products other than fire resistant boards, in contrast to the approximately 4 000 tonnes (mostly amosite) used in both 1970 and 1973. This reflects the fact that asbestos is no longer widely used in manufacturing of these products, which now contain alternatives such as man-made mineral fibres and vegetable fibres.

A46 Pipe and boiler lagging in engineering works, power stations, hospitals and similar large buildings often consisted in the past of a layer (2 cm to 13 cm thick) of 85% magnesia reinforced with 15% asbestos fibre (in many cases, crocidolite), with a surface coat of asbestos composition about 1 cm thick. (The fact that magnesia is a white substance can often misleadingly suggest that no crocidolite is present). Similar materials have also been used in locomotives and railway carriages built before 1967. In low temperature applications, hairfelt or cork with a surface coat of asbestos composition about 1 cm thick would be used. In addition, starch-bound asbestos paper in roll form is supplied to one customer who corrugates the paper for use as a pipe wrap for heat insulation. Old methods of mixing on site and cutting prefabricated sections could generate considerable quantities of dust. More recently mineral wool has come to replace asbestos in pipe and boiler lagging.

A47 Woven asbestos has in the past been widely used to manufacture asbestos quilts, mattresses and blankets for thermal insulation, mainly on steam boilers in ships, railway engines and old-style industrial processes. These quilts were filled with loose asbestos or other insulating materials. The main advantage was portability, but the dust exposure from installation and repair could be high and in at least one shipyard no new asbestos quilts or blankets are used.

A48 Asbestos cord or rope is widely used in thermal insulation for personal protection on small domestic and industrial pipe work, eg steam drains and hot water supplies. The cord, varying in thickness from 1 cm to 5 cm, is wound round the pipe, sometimes protected by about 1 cm of asbestos composition but often left unprotected. Asbestos rope is also used as a packing round pipes or drains that pass through walls as a rot-free fire-stop. This method is still used in modern buildings. Asbestos cloth is still used in industrial insulation as a covering for rigid insulation materials.

Jointings, packings and seals

A49 Jointing and packings accounted for about 10 000 tonnes of the asbestos fibre used in Britain in 1976. Asbestos is used in a wide range of products, manufactured in a variety of ways, whose purpose is to provide a leak-proof joint between two surfaces. Some of these are produced by further processing of asbestos yarn or fabric. Other primary asbestos products used in jointing and packing manufacture are compressed asbestos fibre and beater addition jointing. Compressed asbestos fibre (CAF) consists of asbestos fibres(about70%), rubber and various fillers mixed together, built up into a laminated sheet and cut to manageable size. Beater addition jointing (whose fibre content is also about 70%) is made by a process similar to that used in the manufacture of asbestos paper.

A50 Because of the variety of methods of manufacture, it is hard to generalise about dust levels. Of the operations peculiar to these products, the mixing of the CAF ingredients produces mean counts at one firm of 1.7 fibres/ml. However, dust levels found by the Factory Inspectorate at operations other than mixing are generally lower than this.

A51 Various asbestos textile products constitute the raw material for some packings, such as plaited asbestos yarn, either impregnated with resins or 'dry' (in which case the yarn is usually of the 'wet dispersion' type). Other jointings are based on asbestos fabrics, impregnated and rubber coated. Asbestos rope is also used for caulking in tunnelling.

A52 Gaskets for automotive and industrial use are manufactured by specialised companies which use as their principal raw materials compressed asbestos fibre jointing material (for which gaskets are almost the sole outlet), and asbestos paper and millboard. These materials are cut to size with guillotines, processed on hydraulic presses and then married with the metal component of the gasket. The guillotining operation generates little dust; measurements taken by one manufacturer at customers' premises have revealed levels well below 2 fibres/ml.

Asbestos cement pressure, sewage and drainage pipes

A53 In 1976 these accounted for about 8 100 tonnes of asbestos used in Britain, of which 1 100 tonnes was amosite. The asbestos content, method of manufacture, and the associated dust levels, are basically the same as for asbestos cement building products (see paras A7–A14 above). About 15% of all pressure pipes (for mains water supply) are made of asbestos cement, and for sewage and drainage pipes the figure is about 6%.

A54 An important use of crocidolite in North America and parts of Europe is in the manufacture of asbestos cement pipes. Crocidolite may be used there (but not in excess of about 20% to 25% of the total asbestos content) because its special properties make it more suitable than other types of asbestos for the autoclave process of pipe manufacture—a process not used in the UK. European manufacture of pipes extends to greater diameters than those made in the UK and the combination of size and process used make chrysotile alone unsuitable in their production.

A55 Asbestos cement pipes are now used principally underground for sewage and water-supply purposes. Their former use for gutters and rainwater pipes is diminishing, but they are still used for flue pipes and vent terminals. Installation involves little further processing except some cutting and turning. Dust levels generated during these processes are much the same as for asbestos cement building products and have already been shown in Table A3. They are also broadly similar to the dust levels found in two studies initiated by the Asbestos Cement Pipe Producers Association in the USA[4]. Tests in the UK have shown that machine sawing outdoors with portable disc cutters can give counts between 5 and 35 fibres/ml over short periods, especially when carried out in trenches. But, when water is used to suppress the dust by means of a portable feed attachment, dust levels can be reduced to below 2 fibres/ml.

Yarns and fabrics

A56 This category of products accounted for about 6 300 tonnes of the chrysotile asbestos used in Britain in 1976. The asbestos content is high (between 65% and 100%). Among the products made are asbestos cloths for protective clothing and safety curtains. The requirements for protective clothing are non-flammability, resistance to molten metal splash, wear resistance, flexibility and seam strength together with the minimum weight per unit area which can be achieved consistent with these properties. BS 3791:1970 details performance requirements and methods of test for asbestos cloth with and without a reflective coating. A minimum thermal protective index for each of four hazards is specified. The life of these products can vary from a few days for gloves used under severe conditions to several years for suits worn occasionally. Asbestos cloths for safety curtains need to be flexible, non-flammable and to have low gas permeability. For metal splash protection they must not melt at temperatures up to 1500°C, must not allow penetration of molten steel droplets and must show some adhesion for the molten metal. The products must meet the surface spread of flame requirements of BS 476 part 7 and for metal splash protection Admiralty specification DG Ships 307.

A57 Most (and, until recently, all) asbestos yarn manufacture has used carding and spinning techniques basically identical with those of the cotton and wool textile industries. Traditionally, asbestos textile manufacture has been one of the most hazardous of all the processes involving asbestos. Where the traditional techniques are used, the process is still intrinsically dusty but during the last decade or so much better engineering control of dust has been achieved. Moreover, a new technique for spinning has been developed which removes the dust risk at this stage almost entirely. In this technique, the asbestos fibres are opened or separated in a liquid mix containing various chemical reagents. The mix is extruded and mixed with a coagulating agent to form thin strips which can then be spun in the normal way but which, because they are still damp, will not give off dust.

A58 The advantage of the new wet dispersion process for reducing health risks during yarn manufacture are clear. The yarn so produced is smoother than that produced by the traditional method and retains its strength more effectively at high temperatures, since it is 100% asbestos unlike the yarn made by the traditional process which contain about 15% nylon or cotton. An important disadvantage, however, is that the smooth yarn does not readily absorb resins and therefore cannot be used for making products such as friction materials in which these resins are used.

A59 Figures supplied by manufacturers confirm that carding, spinning, doubling and winding are the dustiest operations and the 2 fibres/ml level is still regularly exceeded in some of them and appropriate precautionary measures are required.

Asbestos blankets, safety curtains and protective clothing

A60 Fire blankets are used in a wide range of establishments as a reliable means for smothering fires, particularly in laboratories where the presence of chemicals can make the use of high pressure extinguishers hazardous. Little risk is associated with the use of blankets for this purpose as they are applied intermittently. However, blankets are used regularly in some foundries to reduce heat losses when castings are pre-heated ready for repairing cracks. Air sampling tests taken in one foundry where blankets have been used for this purpose have yielded readings well below 2 fibres/ml.

A61 Safety curtains are used to contain splashes and sparks in foundries and a protection for means of escape in case of fire in places of entertainment such as theatres. When used as a protection against metal splashes they can be roughly treated and this could lead to some hazard when they are badly worn or damaged. Theatre safety curtains may be a potential source of airborne fibre when they are raised or lowered; but decoration applied to the curtains helps to seal in the fibres.

A62 Asbestos protective clothing is liable to become damaged with use and should be discarded when this is evident. However, when used in unsupervised situations this procedure may not be followed. High dust counts have been reported in asbestos suits under certain conditions and air lines and helmets for fire-fighting clothing are a particular cause for concern. An inner protective lining can be easily installed in the air lines to reduce any risk from this source.

Asbestos-reinforced plastics

A63 Asbestos-reinforced plastics accounted for about 1 200 tonnes of fibre used in Britain in 1976. The asbestos content varies between about 50 and 70% of the total product. Thermoplastic moulding materials are mixed with asbestos fibres in a special manner and formed into pellets for sale to injection moulders. The plastics so formed have stiffness, good fire retarding properties and a low coefficient of expansion. Dust levels relating to various stages of manufacture are generally low with the occasional high counts associated with machining operations. It is known that these can produce high dust levels, if adequate dust extraction is not used.

A64 Asbestos-reinforced plastics are found very widely in, for example, automotive components, small machine parts (such as fans), road signs and bearings for railway rolling stock, road vehicles and ships.

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1 ACA: *Selected Written Evidence submitted to the Advisory Committee on Asbestos 1976–77*, (SWE), HSE, 1977 p 127.

2 For more detailed information on the manufacturing process for asbestos cement, see SWE pp 7–8.

3 ACA: *Work on Thermal Insulation and Sprayed Coatings*, HSC, 1978, pp 13–15.

4 Equitable Environmental Health Inc. (California): *Asbestos Exposures During the Cutting and Machining of Asbestos Cement Pipe* March 1977, and *Dust Exposures During the Cutting and Machining of Asbestos Cement Pipe—Additional Studies* December 1977.

Appendix B

Methods of reducing atmospheric concentrations of and exposure to asbestos dust

SUPPRESSION BY WET AND DRY METHODS

B1 The production of 'wet dispersion' asbestos yarn is an example of a completely wet process that is carried on with practically no airborne dust being produced. An important method of dust suppression used in traditional 'dry' asbestos yarn and cloth manufacture is the installation of damping rolls on looms and spinning and doubling frames to reduce the dust released from the yarn. This is the most generally used dust control method in spinning, where exhaust ventilation presents severe problems. This method is also sometimes applied, alongside exhaust ventilation, to the weaving process.

B2 Asbestos cement sheets may be cut in the 'green' or uncured conditions to achieve substantial reductions in dust compared to when the sheets are cut dry. At site works, asbestos cement articles may be wetted before cutting or mitring.

B3 When the material can be wetted or thoroughly damped before handling or carrying out a production process, the production of airborne dust will be greatly reduced, but once respirable dust particles have been allowed to become airborne it is not possible to control them by the use of water sprays. Where water sprays are used as a method of damping, eg at some sawing operations, they are most effective when used as a fine mist within an enclosure. In all cases where wet methods or damping are used, it is most important to ensure that the material does not subsequently dry out during the processing or that scraps or waste material do not dry out on floors or in the plant. Ideally, the material should be removed while it is still wet, but this is not always possible.

B4 Asbestos insulating boards are sometimes coated with a sealing agent to reduce the amount of dust produced, but both boards and sealing treatments vary so that it is not possible to generalise about the degree of dust suppression achieved. Asbestos textiles can also be effectively treated after weaving to reduce the dust emission at subsequent operations or during handling.

ENGINEERING CONTROL METHODS

B5 These may be conducted by total or partial enclosure with extraction ventilation, or by local exhaust ventilation.

Total or partial enclosure

B6 Total enclosure of a standard such as is used when handling radioactive substances is not generally used in manufacturing processes involving asbestos. Here, it is more common for an enclosure to have comparatively small openings to allow the entry and egress of material and the manipulation of the controls or the process.

B7 Partial enclosures have been used successfully outside the UK to control the dust produced in fibre grinding or milling, disintegrating and separating and on conveyors transporting fibres. Partial enclosures are also used to supplement local exhaust ventilation in a number of cases, in particular where local enclosures are fitted around carding machines. This is in addition to the local exhaust ventilation that is connected to a considerable number of points on the carding engines. Elsewhere, small perspex enclosures have been fitted on tools for drilling and machining resin-bonded asbestos materials. The local exhaust ventilation duct is then carried through the enclosure to a point close to the tool. The ventilation thus constitutes the main element in the control of the dust, but the enclosure increases the protection afforded without the need for further extraction.

B8 To prevent the escape of dust from an enclosure it is usual to apply extraction ventilation to the whole of the enclosure. For this extraction to be effective air must be exhausted from the enclosure at a rate that will ensure that there is at all times an inward flow of air at every part of any opening. To reduce the volume of air that is extracted to a reasonable quantity the size and number of openings must be kept to a minimum. The velocity of inward air flow through the openings must be such that it will overcome any turbulence or air movement emanating from the plant within the enclosure, the movement of materials into or out of the enclosure or caused by the actions of the operator working the plant. In addition the inward air flow must also be capable of overcoming air movement in the general atmosphere outside the enclosure such as shop draughts and air displacement by moving vehicles or people. These requirements are now well recognised in manufacturing processes and applied with increasing success.

B9 Where there is little disturbance or air movement either inside or outside the enclosure, an air velocity of 0.5 m/s may suffice for control but in most factory environments a velocity of at least 1.0 m/s is usually found to be needed for effective control, while under certain unfavourable conditions considerably higher velocities may be required.

B10 An enclosure from which one side or a large part of one side has been removed is often called a booth. An effective booth contains the points of origin of the dust, and the air flow into the open face is such that fortuitous air movement outside the booth and turbulence included inside by the process are overcome and the dust is not allowed to escape. In recent years asbestos users have developed a specially designed booth for use during the opening of bags of fibre. It provides for the disposal of the empty bag and for weighing and blending operations, so that the operator is able to observe the scale head without being exposed to the dust produced by the manipulation of fibres and other powders.

Local exhaust ventilation

B11 In many processes such as drilling, grinding or cutting with circular saws or abrasive discs, it is not possible to enclose the sources of dust, so local exhaust hoods are used as a means of controlling the dust. This is the most common method of dust control in use in the asbestos industry and, when properly designed and installed, can provide effective control below the current hygiene standard in most cases where dust is generated at a defined source. However, it cannot usually provide control where dust is evolved over a wide area or at indeterminate positions, such as when boards or other articles are being transported or handled, or during delagging, dismantling and demolition operations.

B12 In recent years considerable improvements have been made to the conventional designs of local exhaust hoods for many processes and operations, while new hoods have been produced for use with, for example, circular saws and abrasive cutting discs (both when mounted in benches and when used as portable tools), for drilling machines and also for sanding, routing and grinding operations.

B13 For effective control, it is essential that exhaust ventilation systems should be 'tailor made' for the particular operations that are being carried out. Where problems have arisen, it has usually been found that systems have been badly designed and installed because of a lack of experience and expertise in the basic principles of local exhaust ventilation.[1]

B14 The design process must begin with the hood or entry point of the dust into the system. The position, size and shape of the hood and the air velocity required for effective control must be determined before the rest of the plant can be correctly designed. Yet it was common practice, a few years ago, to design and install systems on the basis of some arbitrary design criteria and to improvise the hood after the rest of the system was completed. This practice led to a considerable number of failures of local exhaust systems which then had to be extensively modified after the systems were completed, since, if the system does not capture most of the dust and cause it to flow into the hood, the whole system is a failure, even though the ductwork, fan and filter units may be of a very high order and working to specification.

B15 To design a system correctly it is necessary to determine all the characteristics of the generation of the dust and the air flow pattern at the process. For this purpose a high intensity light beam to illuminate by the 'Tyndall' effect dust particles that are invisible in normal lighting has been found to be a valuable item of equipment. It is essential for the hood to be located close to the point of generation of the dust, because the air velocity pattern in front of the hood approximately follows an inverse square law so that doubling the distance between the hood and the source of the dust will require four times as much air for control. There is also a finite distance in front of the hood beyond which increase in air flow will not give effective control. The sizes of the fan and filter unit are directly related to the amount of air needed to produce an effective capture velocity in front of the hood, so that a small hood correctly located may be able to control the dust more effectively than a much larger hood placed further away, even with a much larger fan and filter unit. Careful study of the relationship between the hood and the behaviour of the dust at source can thus yield better control and economies in the whole of the system.

B16 The pattern of air velocities induced in front of hoods under suction conditions is not completely understood and there are discrepancies between various authorities. Work is now going on in the Research and Laboratory Services Division of HSE to resolve these. However, enough is known to enable practicable systems to be designed that will effectively control the dust generated at most industrial processes involving asbestos.

B17 Low-volume high-velocity exhaust ventilation has been used very successfully for the control of asbestos dust at machine tools such as lathes, milling machines, multi-spindle and single spindle drills, at band saws and at portable tools such as hand-held saws and drilling machines. Where small precise dust sources are produced by high speed cutting operations, the low-volume high-velocity system has been found to be more effective than ordinary exhaust ventilation and less cumbersome. The system uses specially designed captor hoods in which the hood or entry point of the dust is very small. The point of entry is placed very close to the point of generation of the dust and entrains small quantities of air (usually less than 0.05 m^3/s), at high velocities (usually greater than 50 m/s). The high air velocities are necessary to achieve capture of the dust close to high speed cutters and to produce them it is usual to use a multi-stage centrifugal exhauster and not a conventional fan. The dust is conveyed through smooth bore flexible or steel piping to minimise drag.

FILTRATION EQUIPMENT

B18 In premises using exhaust ventilation as a means of controlling the dust, some form of filtration or separation equipment is invariably installed to remove the dust before the air is either discharged to the general atmosphere or returned to the workroom, although at the time that the Asbestos Regulations were made there were no specific legal requirements in the Regulations or Factories Act for the installation of such filters.

B19 The most common type of equipment is the fabric filter, but occasionally centrifugal separation or wet scrubbing is used. Over a number of years the fabric filter has been developed from the open sock or cylindrical bag filter installed in large galleries or baghouses to the modern enclosed modular design of plant or unit type filters. The modern plant may use either cylindrical bags or envelope type filters of a wide range of both woven and felted materials depending on the type of material being filtered, the temperature of the air or gases, the conditions of use and the methods of cleaning the filters that are employed. The filters may be cleaned either by some form of mechanical shaking or agitation, or by using reversed air cleaning where small jets or pulses of compressed air are used to reverse the airflow through a bag or limited area of the filter for a short period of time.

Generally the older plants are fitted with mechanical shakers and use woven fabric filters while reverse air cleaning is more often used on modern plants where felted fabrics are used. Felted fabrics have more efficient collection but they generally do not have the strength and flexibility necessary for mechanical shaking.

B20 For correct functioning the material from which the filter is made must be properly applied and the most suitable material chosen for the job. One of the most important criteria is the filtration velocity, that is the average velocity of the air through the effective working area of the fabric. For asbestos dust and fibres the filtration velocity should not exceed 0.025 m/s when woven materials are used, while for felted materials the filtration velocity should not exceed 0.05 m/s. It is found, in practice, that asbestos fibres are readily retained by a fabric filter and that the collection efficiency of a filter is considerably better when asbestos dust is being collected than when particulate matter only is being collected.

B21 More than one type of separator or filter may be used in a system, for example, a cyclone may be used to remove fragments or larger particles from an air stream before a fabric filter is used. Where air is returned to the workroom it has become normal practice to install a secondary filter behind the primary fabric filter to act as a fail safe device in the event of a primary element failure and to increase the filtration efficiency. This secondary filter may well be another fabric type but glass fibre/paper types of filter such as the HEPA or 'absolute' filters have also been used.

B22 The dust collected by the filter must be removed in a safe manner to prevent it escaping into the atmosphere. The normal method is for the dust to be discharged into impermeable bags either suspended from the base of the collecting hopper or contained in self sealing bins. It may also be conveyed back to the plant for re-use under controlled conditions or conveyed pneumatically to a bagging system for safe disposal. Where material is bagged off manually at the base of the hoppers, problems frequently arise due to spillage or leaking bags as considerable care is required in the tying off, removal and replacement of the bag.

PLANT COMMISSIONING AND MAINTENANCE

B23 Although many properly designed exhaust ventilation plants function correctly, there have been cases where, for a number of reasons such as incorrect design information or changes in the process, plants have not always efficiently controlled the dust, although operating at the specified conditions of air volume and pressure. It is very important, therefore, that all new plant should be carefully checked to ensure that effective control of the dust is achieved. This may be done by the use of the high intensity Tyndall light beam to identify areas where control is not effective and by sampling the air around the dust source.

B24 When the dust control is satisfactory measurements should be made of air volumes and static pressures at hoods and the branch ducts. The results of these measurements should be systematically recorded so as to form the basis of subsequent tests of the system as required by the Asbestos Regulations. Where blast gates or dampers have been used to adjust the air flow these should be locked in position to prevent unauthorised alterations.

B25 To ensure continuing correct operation all ventilation plant requires at least as much careful and systematic maintenance as any part of the process plant. The Asbestos Regulations in fact require that exhaust ventilation plant be inspected at least once in every seven days and thoroughly examined and tested at least once in every fourteen months.

B26 The weekly inspection should check that all hoods, etc, are in their correct position, are not damaged and are properly secured; that all ductwork, including flexible connections, is in good order, undamaged and properly supported with no obvious leaks and is not choked with dust deposits; that the filter plant and shaking or cleaning gear is operating correctly; that hoppers are not overfilled; and that the routine emptying is being regularly carried out. Where gauges are fitted these should be checked to see that they are within the normal operating range.

B27 The thorough examination and test every 14 months should be carried out by a competant engineer who should have a full knowledge of the plant and how it should operate. The purpose of the examination should be to ensure that the plant is effectively controlling the dust at the point of origin and that there is a minimum of dust entering any workroom or to the general atmosphere. The plant must also be in such good mechanical repair that it can reasonably be expected to continue to control effectively the dust until the next thorough examination. These tests are regularly carried out at the larger manufacturing firms by the firm's own employees, but at smaller firms they are often done by representatives of the insurance company or of the firm which installed the ventilation equipment. However, it seems that basic maintenance checks are occasionally omitted and such omissions should be rectified.

B28 The report of the thorough examination is required by the Asbestos Regulations to contain all the details specified in the Certificate of Approval No AP1 and in particular should state whether the dust was effectively controlled, what defects were found and record the measurements of static pressures at the hoods.

PROTECTIVE EQUIPMENT

B29 The operations where it is often or always impracticable to control asbestos dust by means of exhaust ventilation, and where protective equipment is therefore needed, include the removal or treatment of asbestos insulation, the demolition or dismantling of asbestos-insulated plant, and the installation of insulation boards in buildings or ships. Factory processes where protective equipment may be required include the disposal of dust from collectors, work in filter galleries or bag houses, and attending to machinery inside enclosures at some operations such as carding.

Standards of protective clothing

B30 Protective clothing is defined in the Asbestos Regulations as: overall and headgear, which in either case will, when worn, exclude asbestos dust. For certain cases, where in operations such as delagging quantities of asbestos are liable to fall to the floor, protective clothing should include suitable footwear. Additionally, the Regulations require the provision of suitable accommodation, in a conveniently accessible place, for storing the protective clothing when it is not in use.

B31 Contaminated protective clothing should be cleaned at suitable intervals either within the factory where it is provided or at another place, provided that prior to dispatch it is properly packed in suitable containers which are clearly and boldly marked with the words 'Asbestos-contaminated clothing' and which prevent the escape of asbestos dust. However, there is no precise criterion for determining when clothing becomes 'contaminated'.

B32 The types of protective clothing suitable for use in complying with the Asbestos Regulations are described by the Asbestosis Research Council[1]. Overalls made from man-made fibres are usually most suitable since asbestos tends to cling less to garments made from this type of material. The style of garment is to some extent governed by the operation which is to be undertaken. The one-piece boiler suit type, fitting closely at neck, ankle and wrist, is generally thought to be the most suitable type. If short sleeves are preferred for safety reasons or for coolness, the exposed part of the arm should remain uncovered so that normal clothing sleeves are not exposed. Headgear must be provided, in the form of a close fitting cap or hood, and should be of similar material to that recommended for other clothing.

Standards of respiratory protective equipment

B33 The respiratory protective equipment provided to comply with the Asbestos Regulations 1969 must be approved by HM Chief Inspectorate of Factories. It is important to note that there are several types of approved respiratory equipment which range from simple half mask respirators to complicated breathing apparatus.

B34 Each year a certificate of Approval (Respiratory Protective Equipment), form F2486 is produced; the certificate is issued on 1 July and in it the Schedule contains a list of those respirators which have been approved for the purposes of the Asbestos Regulations. Usually the certificate remains in effect for 12 months unless the approval for a particular item of respiratory protective equipment is revoked. A condition of approval is that no material change may be made to the equipment. Supplementary certificates may be issued at any time in the year.

B35 Before an approval is granted extensive laboratory tests and wearer trials must be undertaken to ensure that the particular equipment provides an acceptable standard of protection under the conditions of use. The degree of protection is reflected in the limitations specified for the individual items listed in the Schedule to the certificate. These limitations state the maximum concentrations of asbestos dust of various kinds against which each item of respiratory protective equipment will offer protection.

B36 The different kinds of respiratory protective equipment approved in the Certificate of Approval fall for the purpose of the Asbestos Regulations into various categories:

(a) Half mask dust respirators. These cover the mouth and nose only. They are approved for use where the dust concentration does not exceed 20 fibres/ml or 2 fibres/ml of crocidolite. These respirators are not, however, approved for use in construction operations, including demolition, where crocidolite is involved.

(b) Positive pressure powered respirators (standard efficiency). These respirators incorporate an air pump to make it easier for the wearer to breathe against the resistance of a fine filter. They may be used at any operation where the asbestos dust concentration does not exceed 200 fibres/ml (or 20 fibres/ml of crocidolite).

(c) High efficiency dust respirators. These respirators have full face pieces which cover eyes, nose, mouth and chin, inhaled air being drawn through the filter system by the wearer's own breathing. They may be used at any operation where the asbestos dust concentration does not exceed 800 fibres/ml (or 80 fibres/ml of crocidolite).

(d) Positive pressure powered respirators (high efficiency). These respirators have a high-efficiency filter, an air pump and (usually) a full face piece. They are approved for unlimited concentrations of asbestos dust at any operation.

(e) Positive pressure powered bloused (standard efficiency). This type of respiratory protective equipment consists of a hood and blouse supplied with a source of filtered air. The equipment covers the entire head and upper part of the body and the exhaled and surplus air passes from the inside to the surrounding atmosphere at the wrist or waist. This equipment has been approved for use where the asbestos dust concentration does not exceed 200 fibres/ml (or 20 fibres/ml of crocidolite).

(f) Certain disposable filtering facemask respirators may be used provided they have not been worn on a previous shift, or by another person for more than 8 hours. The conditions of use are similar to those for half mask respirators.

(g) Breathing apparatus. This type of respiratory protective equipment does not depend on filtering the ambient air and thus is suitable for use in high concentrations of asbestos dust.

B37 The type of respiratory protective equipment most appropriate for a given operation clearly depends on the dust level. Most factory processes requiring respiratory protective equipment are not dusty enough to require respiratory protective equipment of a higher standard than the half mask dust respirator although in certain situations, such as maintenance of dust collection plant, one of the other respirators will normally be needed. Building operations or works of engineering construction where asbestos is being removed or treated require a high standard of respiratory protective equipment and this is a statutory obligation if crocidolite is involved. Normally positive pressure or high efficiency dust respirators are worn. Where any asbestos removal is undertaken in the dry state, the highest standard of respiratory equipment is required if this involves crocidolite (for example, airline breathing apparatus or high efficiency positive pressure respirators); if white asbestos only is involved then the minimum protection expected will be the high efficiency dust respirator or the high efficiency positive pressure respirator.

Provision of protective equipment

B38 The experience of the Factory Inspectorate is that the requirements to provide protective equipment are very widely observed in factories. Some of the major companies regularly supply protective clothing in circumstances even where it is not required by the regulations (that is, where the asbestos dust is adequately removed by exhaust ventilation), and make respiratory protective equipment freely available to their employees on request.

B39 Most employers (including all major companies) launder asbestos-contaminated protective clothing on their own premises or engage a specialist firm to do this. There is, however, nothing in the regulations to stop an employer from allowing his employees to take the contaminated clothing home for washing, provided it is packed in an impermeable and properly labelled container. There is, however, no advice presently available on how to launder asbestos-contaminated clothing at home.

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1 Asbestosis Research Council: Safety Guide No 1: *Protective Equipment in the Asbestos Industry*, ARC.

Appendix C

Removal, dismantling, stripping and demolition of asbestos

C1 Here we describe how the demolition, dismantling and thermal insulation industries are organised, since they present a considerable contrast to the industries described in Appendix A which use raw asbestos in manufacturing, and then describe the various operations in this work in greater detail than in our first report.

ORGANISATION OF THE INDUSTRIES

C2 Instead of three or four large companies dominating the scene, as in the manufacture of asbestos products, we find several hundred firms involved throughout the UK with workforces varying in size from 200 or more employees down to one or two, though many of the smaller firms may be subsidiaries or associates of major companies, especially in the thermal insulation industry. In the thermal insulation industry, too, some of the major companies are subsidiaries of the manufacturers. Most of the larger firms, but by no means all of the smaller ones, belong to one of three trade associations as shown in Table C1.

A further feature of the demolition industry worth commenting on is the very high labour turnover, and the frequent lack of adequate training in safety matters or health risks.

C3 The Demolition and Dismantling Industry Register was set up in 1974 with a view to encouraging responsible firms. The Register has received government support. Companies have to meet certain criteria in order to belong to it, and in general only registered companies can win contracts from central government and local authorities who have agreed to follow their example. A similar register was set up by the TICA in agreement with the trade union side of the National Joint Council for the thermal insulating industry. There has, however, been some disagreement about how successful these arrangements have been in fostering safer working methods in the industries concerned.

Table C1 Organisation of work in demolition, dismantling and thermal insulation industries

Type of work	*Companies involved*	*Number of workers involved*
Installing, repairing insulation (especially prior to replacement)	160 members of Thermal Insulation Contractors Association (TICA), of which about 60 regard themselves as specialists in asbestos stripping	Approximately 8 000–10 000
	Companies not members of TICA	Not known
Dismantling and demolition (including stripping of asbestos)	Approximately 600 companies on Dismantling and Demolition Industry Register (DDIR) (some of whom are members of National Federation of Demolition Contractors or British Scrap Federation or both)	Possibly 6 000 in demolition 3 000 in dismantling
	Companies not on the DDIR	Not known

C4 It will be seen that there is some overlap between the sort of work done by TICA members and that done by firms on the DDIR: both may engage in the stripping of asbestos-based insulation. But, where TICA members do this work, it is usually as a preliminary to the installation of new insulation in a building or ship, while for DDIR members, it is nearly always part of a demolition or dismantling operation. Even so, a few demolition contractors engage TICA members to strip asbestos-based insulation before demolition is begun, and TICA members carry out about half the asbestos insulation stripping in electricity power stations.

C5 The distinction between dismantling and demolition is that dismantling involves the removal of industrial plant and equipment whereas demolition refers primarily to the destruction of the fabric of buildings. Large scale contact with asbestos insulation material is much more likely during certain dismantling operations (such as at power stations and gas works) and the demolition of some industrial premises (such as asbestos-sprayed factory structures) than in the demolition of houses, flats and offices. Although some companies will undertake both kinds of work, there is a considerable degree of specialisation in that most dismantling is done by members of the British Scrap Federation while many members of the National Federation of Demolition Contractors and non-member firms carrying out demolition work handle only small scale demolition of non-industrial buildings. So, while employees of some dismantling contractors will be regularly exposed to asbestos insulation, the employees of other demolition companies will seldom come across it.

C6 Not all de-lagging work is carried out by contractors. Some large organisations such as the Ministry of Defence and British Railways sometimes use employees of their own. It may also be done by heating and ventilating engineers in the course of their work, although the committee notes that in 1976 the Heating and Ventilation Contractors Association issued to its members a Safety Circular (SC 76/11) on asbestos, which advised them to sub-contract all de-lagging work to a specialist firm. Finally, in most establishments where asbestos-based lagging is found, maintenance engineers are employed from time to time to strip or disturb lagging in order to repair pipes, boilers and other plant, or to permit inspection by a boiler engineer or surveyor on behalf of the firm's insurance company.

DESCRIPTION OF THE OPERATIONS

C7 The Asbestosis Research Council[1] and British Scrap Federation[2] recommend that all sprayed asbestos coatings and asbestos-containing thermal insulation materials should be thoroughly soaked or sprayed with water before and during the stripping operation. Once again, individual operations differ from each other in ways which may significantly affect the amount of dust generated. Nevertheless, figures from HMFI show that, with thorough soaking, dust levels can be brought below 5 fibre/ml whereas, when material is removed dry, dust levels exceed 20 fibres/ml and can reach 100 fibres/ml. Water sprays are less effective than soaking in keeping dust levels down and levels of up to 40 fibres/ml can be found when they are used.

C8 There is a wide frequency distribution of dust concentration at processes involving asbestos lagging as operations can involve crocidolite as well as white asbestos. The eleven sites at which measurements have been taken by HMFI include power stations, gas works, chemical plants and the demolition of factory structures covered with sprayed asbestos insulation, but no non-industrial premises. Many of the observations were based on short-term sampling and are therefore peak exposures but 73.4% of results are below 10 fibres/ml, which may be the result of very short exposures or effective predamping.

C9 Clearly these are unusually dusty operations and, even if the material is wetted during removal, an employer must supply his operatives with protective clothing and respiratory protective equipment if he is to be sure of complying with the Asbestos Regulations 1969. We are assured that reputable contractors do provide this protection, but we have been told that standards vary widely and we have no doubt that some of this work is done without adequate protection.

C10 Sprayed asbestos coatings and asbestos-containing insulating materials have now largely been replaced by products not containing asbestos, so stripping operations involving contact with asbestos will become less frequent as time passes. But, as these products can remain in buildings for decades, it will be many years before the last operation involving asbestos is completed.

C11 British Rail have told us that they intend to remove totally this type of asbestos insulation from all traction and rolling stock in accordance with a programme already under way. The bulk of the removal programme is being carried out by BR Engineering Ltd with trained staff in specially-designed removal facilities situated at nine locations. Removal is also being carried out, on a much smaller scale, by trained personnel at facilities within the Chief Mechanical and Electrical Engineer function. Because these facilities are static, the removal operation is more akin to a factory process than most dismantling or stripping operations.

C12 In building products such as asbestos insulation board and, especially, asbestos cement, the asbestos content is lower than in sprayed coatings and plant insulation and fibres are in general less likely to be released. This obviously affects the amount of asbestos dust likely to be generated during demolition operations involving the breaking up of insulation board and asbestos cement on site. But it is impossible to generalise confidently about the dust levels. On a site where for example asbestos cement roofing sheets have been smashed down so as to expose the steel framework of the building for demolition, the broken asbestos cement fragments on the ground may be further crushed by heavy equipment moving across them. No systematic studies have been carried out of the dust levels found on demolition sites where products containing asbestos have been pulverised in this way, but there is at least a prima facie risk that the hygiene standard may from time to time be exceeded.

C13 The removal of asbestos sliver cable wrap may present an occasional but significant hazard as it will often be done unsupervised as when a scrap dealer strips cables to recover the metallic core.

C14 The householder will also come into contact with airborne asbestos dust if he undertakes stripping or dismantling of the kind described. But this is unlikely and, in any case, will be intermittent or on isolated occasions, since few domestic premises contain large quantities of asbestos-based lagging.

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[1] Asbestosis Research Council: *Control and Safety Guides 3*, ARC.

[2] British Scrap Federation: *The Processing, Handling and Disposal of Asbestos Contaminated Materials in the Scrap Industry*, BSF, Pamphlet 10.

Asbestos and the general public

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Electron miscroscope photograph of chrysotile fibres

34 The previous chapter gave information on the uses, processing and handling of asbestos at the workplace which has been a main area of concern about the safety of asbestos and related products. Another important area of interest has been the occurrence of asbestos outside the workplace – as a result of work processes or through contact with goods, facilities or services used by the general public. Before looking at particular areas such as waste collection and disposal, asbestos in and outside buildings, consumer products and asbestos in water and food, it is important to be aware of the methods used for measuring concentrations of asbestos dust in the general environment and how these differ from those used in the workplace.

Measurement of asbestos outside the workplace

35 Asbestos has been monitored in the workplace for a number of years and methods for the sampling and analysis of asbestos dust have been developed as a part of the control of occupational exposure and compliance with the hygiene standard. Although these methods are still being refined, a standard, reproducible technique does exist.[1]

36 The method generally used in the workplace of sampling by trapping fibres on a membrane filter and counting these under an optical microscope cannot readily be used for measurement of the lower concentrations of asbestos in the general environment. For example, sampling large volumes of air captures other particles in the atmosphere as well as asbestos fibre which are thus obscured when examined under a microscope. With some techniques under development more sophisticated methods are required to separate the different particles before the sample is assessed.

37 Various methods have therefore been tried to measure asbestos concentrations outside the workplace but each alternative is associated with technical difficulties. A summary of these is given in Appendix D. In view of the lack of comparability of most environmental monitoring results, these data can be used only to give a broad indication of the order of magnitude of asbestos concentrations outside the workplace.
So far most of the environmental monitoring work has either not differentiated between the different forms of asbestos, or has been aimed primarily at chrysotile – the most common form of asbestos. In only a few cases have amosite or crocidolite been separately monitored, and this was done where it was already expected that they would be found individually or in combination. However, even with these significant qualifications on the measurements made of asbestos in the wider environment, estimates can be made of its likely occurrence and steps have been taken to minimise any possible risk in several fields.

In buildings

38 Since more than 60% of the asbestos imported into the UK is used in the construction of buildings, the performance of construction products containing asbestos and the possibility of the generation of asbestos dust is of particular importance.

39 There is relatively little information about the asbestos dust levels to which occupants of buildings which contain asbestos-based materials are likely to be subjected. However, the results of studies which have been conducted show that in most cases, high concentrations of asbestos dust – some approaching the appropriate occupational hygiene standard – were found to be associated with the presence of sprayed asbestos and activities which tended to produce a significant disturbance of air in the building. A more detailed account of these studies is given in Appendix E.

40 Firm conclusions about asbestos dust levels in buildings cannot be drawn from the present data. However by the figures cited in Appendix E the number at risk is probably small. We nevertheless believe that a comprehensive survey of asbestos dust levels in buildings should be undertaken, to determine how frequently such dust concentrations occur.

Outside buildings

41 As shown in Table 7, Chapter I, friction materials account for a considerable tonnage of the asbestos imported into the UK (about 11% in 1976), and it is reasonable to expect that some of the fibre contained in them will be released into the air during braking or clutch application. There is considerable uncertainty about the levels of asbestos dust that these operations can generate in different circumstances, but they do at any rate seem to be extremely low (far below 2 fibres/ml). However, it is thought by many that most, certainly urban, environments are contaminated by detectable amounts of asbestos fibres, although in most cases the source of the contamination is not identified.

42 Levels reported around factories vary from 0.1 fibres/ml (1/20 of the hygiene standard) to 2.5 ng/m^3 – about 5 orders of magnitude below the present hygiene standard. Information on factory emissions again is limited, and further monitoring is necessary. Higher levels have been reported around mining facilities in the USA. Although geological formations which may be associated with asbestiform minerals do occur in certain parts of the UK, there is no mining of asbestos and it seems unlikely that there are any significant deposits of fibrous minerals which could lead to contamination of the environment.

43 The major asbestos manufacturing companies have indicated that as much waste as economically and technically feasible is recycled. The materials disposed of consist of residual amounts of unworkable or fine (filter) dust, together with those materials, including off-

cuts, from bonded asbestos (resin or cement) which once produced cannot be reintroduced into the process. Jointing waste which has not been fully cured can be recycled and is already handled in this manner by the industry.

44 It has been estimated that during 1976 between 110 000 and 120 000 tonnes of notifiable asbestos waste, consisting mainly of fibrous asbestos, were disposed of in landfill sites in England. However, this may include large consignments of bonded waste (in cement and resinous matrices), sludges and filter cakes or fibrous wastes mixed with inert wastes. Large scale generation of fibrous crocidolite wastes come from the demolition of power stations and other manufacturing units; the destruction or de-lagging of British Rail coaches; the demolition of large hutted areas (particularly dating from the war years); and major de-lagging and re-lagging operations throughout industry. The local annual fluctuations in notifiable asbestos waste arising can be considerable, depending particularly upon the demolition of power stations and other large-scale operations of limited duration. During the next two or three years it is expected that the demolition of power stations in England will produce waste containing several thousand tonnes of asbestos, including substantial quantities of crocidolite. Practices followed in disposing of asbestos waste and measurements of dust concentration by HMFI are set out in Appendix G.

45 Information on concentrations of airborne asbestos around waste sites is more limited and varies depending on the site. It seems likely that much would depend on the way in which the site is managed, the frequency of dumping of asbestos wastes, whether they are adequately covered and other factors.

Waste collection and recycling

46 Degradation of asbestos at waste disposal sites will depend upon soil conditions, and the nature of the sites themselves. If conditions are very acidic, which may occur from other chemical waste disposal, then chrysotile asbestos may well be degraded, although amphibole asbestos varieties will be virtually unaffected by changes in the acidity or alkalinity of disposal sites. Composite wastes such as asbestos cement may be subject to chemical changes in the soil which would remove the bonding agents, leaving the asbestos fibre unaffected. Similarly resinated asbestos materials would be subject to bacterial and chemical attack which would free the fibrous component which would remain virtually undegraded.

47 Table 9 gives the amount of waste containing asbestos disposed of by the three major asbestos product manufacturing groups of companies in the UK during 1975 and also gives an indication of the various forms in which waste asbestos is likely to arise.

Table 9 Asbestos-containing waste deposited by major manufacturers during 1975 (*tonnes*)

Fine dusts	9 340
Loose fibre, swarf, sweepings, etc	1 060
Off-cuts, broken pieces and rejects of friable materials	750
Off-cuts, broken pieces and rejects of high density materials	32 300
Sacks and bags	240
Wet scrap, slurries and sludges (around 20% solids)	18 310
Total	62 000

Source: DOE Waste Management Paper No 18: *Asbestos Wastes.* Technical Memorandum on arisings and disposal including a code of practice. HMSO 1979.

Note: The asbestos content of the figures in this table will be less than the actual tonnage of waste, as each type will contain materials other than asbestos.

48 Special arrangements are not normally made for the collection of household waste containing asbestos. Domestic articles containing asbestos as one of their constituents form such a small proportion of ordinary domestic waste that it has not been thought necessary to treat them separately, before disposing of them by conventional methods – arrangements can often be made with the district council (as the collection authority) for special collection of significant quantities of refuse including asbestos waste.

49 With this exception, we consider that conventional methods of waste disposal are appropriate for removing normal quantities and types of domestic waste containing asbestos.

Do-it-yourself and domestic applications

50 Asbestos has a wide variety of domestic applications. In addition to its uses in building construction, it is found in consumer goods, including some do-it-yourself materials and in less apparent applications as part of the fixtures and fittings of the home, such as in fuse boxes.

51 Asbestos cement products are perhaps the most widely used, for example as rainwater goods (pipes and gutterings), as sheet materials for the building and roofing of sheds and garages, in the linings of doors and soffits and in many other locations. Insulation boards containing asbestos are used for partitioning. Some textured paints and materials such as asphalt roofing mastic may contain asbestos.

52 In consumer products asbestos string, paper and millboard have been used to provide thermal and electrical insulation in electric toasters, hair-driers and similar appliances, although their use for these purposes is declining. Asbestos in the form of paper and millboard is used for simmering pads and ironing board pads. Asbestos cement sheets are tending to replace asbestos paper for ironing boards. Asbestos textiles have been used for oven door seals on cookers and for oven gloves.

53 Do-it-yourself applications span a very wide range of products and, with the present trend towards their greater use, many of the products used at work are also used in the do-it-yourself field. The most widely used products include asbestos cement sheeting, insulation boards, brake lining kits, wall plugging compounds and latex/asbestos backed sheet flooring. Some paints providing a textured finish and others for car under-

sealing contain asbestos but we are told that plaster crack fillers manufactured in the UK do not contain asbestos.

54 We have not attempted to make an exhaustive list of all products containing asbestos which are present or used in the home. However a study recently completed on behalf of the US Consumer Product Safety Commission[2] examined the range of consumer products in which asbestos was used. The main purpose of the research was to identify and describe products, to determine the amount and method of asbestos incorporation; to assess product use to determine if and how asbestos might be released; and to estimate consumer presence during conditions or activities which might release asbestos. Over 120 data sheets for various products were included in the report but, perhaps because of the obvious difficulties, no measurements of likely dust concentrations were given and the authors confined themselves to indicating whether a particular product might be capable of releasing airborne fibres and the circumstances under which this might occur rather than defining a precise hazard. Nevertheless, it is apparent that very few products in use in the USA are likely to release fibres to such an extent as to present a serious threat to health.

55 Asbestos is only harmful if fibres are released and inhaled, and thus measurements of dust concentrations or some estimate of them is necessary to assess the exposure of the individuals to asbestos and thus any possible risk to them. The tendency of asbestos fibres to become airborne and the airborne concentration of dust thus produced will depend largely on the friability of the product, the percentage of asbestos in the material and the treatment to which it is subjected.

56 Both the Consumer Product Safety Commission in the USA and the Department of Prices and Consumer Protection here have taken action to ensure the withdrawal from the market of certain products where there appeared to be a significant risk. Artificial ash containing asbestos on logs for gas fires is a case in point. The USCPSC took similar action in respect of asbestos containing patching compounds used to repair interior plaster but as far as we know, no such products are used in the UK.

57 In the more general case people should be able to identify products which could release asbestos and should be made aware of any possible risk so that they can take appropriate precautions. For these reasons, the major UK manufacturers instituted a scheme in co-operation with the Department of Prices and Consumer Protection and the Health and Safety Executive for the voluntary labelling of all asbestos-containing products which could, under any foreseeable circumstances, constitute a possible risk to health through the release of asbestos dust whether at work or in the home. This is described more fully in Appendix H.

58 Where asbestos is present in products which are merely present in the home as distinct from being worked on, it seems likely that the airborne concentrations of dust will be very low unless the product is very friable. On the other hand, householders may come into contact with respirable asbestos dust when using certain previously purchased wall plugging compounds containing asbestos and when sawing, cutting, sanding or otherwise working products such as asbestos cement sheets or insulation board. In the first example the total intake of dust is likely to be low as the product is intended to be used in very small quantities, usually wet, and the time involved quite short. In the second case one would normally expect the concentrations of respirable dust generated by domestic applications to be much the same as those found for industrial uses where these occur under similar conditions. The dust concentrations generated will vary with the type of tools used and the precautions taken and total exposure will depend on the length of time for which the work is done. Where domestic applications are carried out mainly by hand, dampened, and for short periods of time, the total intake of dust over a lifetime is likely to be very low. If, for example, the use of power tools is essential, exposure to asbestos dust will be greater but is still likely to be significantly lower than would be experienced in employment on similar work as the time of exposure is usually less. Nevertheless, it would be prudent in such cases to take appropriate precautions to minimise exposure to asbestos dust.

Asbestos in food and water

59 Asbestos fibres may find their way into water and food from various sources, including natural outcrops, asbestos cement water pipes, food processing plant containing asbestos components, and as a consequence of general environmental contamination. The problem of asbestos in food and drink has been examined separately by the Food Additives and Contaminants Committee which advises Ministers on the exercise of their powers under Food and Drugs legislation on matters relating to contaminants, additives and similar substances which may be present in food. A summary of the committee's recommendations is given at Appendix J.

60 For the purposes of our report it is sufficient for us to record that the Food Additives and Contaminants Committee has received toxicological advice concerning the ingestion, as opposed to the inhalation of asbestos, and examined the pathways by which asbestos may enter the food chain and the possible levels of exposure to the general public from these sources. We note in the report from the Committee on Carcinogenicity of Chemicals in Food, Consumer Products and the Environment that studies to investigate the carcinogenicity of ingested asbestos have generally yielded negative results and that there is no clear epidemiological evidence of increased incidence of carcinoma in the gastro-intestinal tract attributable to asbestos in non-occupationally exposed populations.

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1 ACA: *Measurement and Monitoring of Asbestos in Air*, HSC, 1978.

2 Kearney, AT Inc.: *Review of Asbestos Use in Consumer Products*, US Consumer Product Safety Commission, April 1978.

Appendix D

Difficulties encountered in measuring asbestos dust concentrations outside the workplace

D1 Optical microscopy is not adequate to evaluate fibres in the sub-micrometric range but work is taking place to ease fibre identification above this range by dispersion staining and polarised light[1].

D2 An electron microscope permits counting of smaller fibres at lower concentrations but is difficult, expensive and time consuming. Gravimetric techniques which measure asbestos dust by weight rather than counting have also been used, based mainly on x-ray diffraction methods, but they give no indication of the size range of fibres present. Conversion factors for fibre weights to fibre counts vary widely, depending not only on the inherent differences between fibre size ranges in samples from different sources, but also on the fact that sample collection and preparation will themselves lead to degrees of breakdown of fibres and hence changes in the ranges of particle size.

D3 Besides their individual difficulties, the use of different techniques – and in particular gravimetric methods as opposed to fibre counting – means that most of the environmental monitoring results reported to date are not directly comparable in any way. For example, the GreaterLondon Council took 54 samples in buildings under their control: 40% of the samples in boiler houses, 37% in houses and the rest in schools or warehouses. They reported no unusually high readings. One problem their survey did highlight was the wide variation in results obtained when samples of this type and density were analysed by different laboratories. We have already recognised this problem in our second report and suggested the creation of a central reference laboratory to improve the consistency of membrane filter counting as well as advocating the use of alternative sampling methods, such as high volume sampling for assessing asbestos levels in the non-occupational environment[2].

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[1] Purdy DR and Williams DH: *Fibre Identification using Optical Microscopy*, Electricity Council, 1978.

[2] Duggan MJ and Culley EW: *The counting of small numbers of asbestos fibres on membrane filters: a comparison of results from some commercial laboratories*, Annals of Occupational Hygiene 21, 85–89 (1978).

Appendix E

Asbestos dust concentrations in buildings

E1 One of the studies that have been done by Byrom et al[1] found that asbestos dust levels in more than 60 out of 73 buildings with construction products containing asbestos were below 0.02 fibres/ml, but researchers also found similar levels in a significant proportion of buildings free of asbestos products. However, it should be noted that Byrom reports a peak figure of 0.08 fibres/ml (that is 40% of the currently recommended hygiene standard for crocidolite). Some of the buildings included in that study were reported to be insulated with sprayed asbestos, but it was not stated whether the sprayed coatings were protected against damage and the report does not make it clear what conditions obtained during sampling.

E2 In most cases where high levels of asbestos are reported, they are associated with the presence of sprayed asbestos and the risk of fibre release is increased if they are inadequately sealed. In a study carried out in a number of storehouses where sprayed asbestos coatings were unprotected, Lumley et al[2] indicated in contrast that mean dust levels could be in excess of the crocidolite hygiene standard even where there was little or no activity, and that the type of activity in a building has a substantial effect on the level of dust in the air by, for example, creating disturbances in the atmosphere. Similar studies in other countries (notably France[3] and the United States) have employed different analytical techniques but the results obtained (in nanograms/m^3) are not comparable to those in the UK; furthermore these results may not be directly applicable to conditions in the UK owing to different patterns of use of products containing asbestos in buildings. Nevertheless, the study by Nicholson et al[4] of airborne asbestos contamination in public buildings in the USA shows that the possibility of dust levels high enough to cause some public health risk cannot be entirely ruled out.

E3 For the purpose of assessing potential risk of fibre release due to deterioration in use, the asbestos products used in buildings may conjecturally be divided into four categories, in descending order of possible risk:

(a) sprayed asbestos insulation

(b) pipe and boiler lagging

(c) insulation board

(d) asbestos cement and asbestos-containing plastic floor tiles, roofing felt, cushion floorings, asbestos paper and paints containing asbestos.

In asbestos cement, the asbestos content is relatively low (10–15%) and it is embedded in a hard and durable material. In normal use, asbestos cement is considered to be unlikely to deteriorate in such a way as to give off dust in excess of the British Occupational Hygiene Society's 1968 occupational hygiene standard of 2 fibres/ml. If unprotected asbestos insulation boards or asbestos cement sheets are used on the input side of a ventilation system it seems possible that the scouring action of the air being forced through it could release asbestos fibres into the general ventilation system. However, this use does not appear to be common and we understand that the Building Research Establishment (BRE) have been unable to identify buildings with this ducting to take measurements to assess any hazard that it might present.

E4 A series of ad hoc tests at the BRE have shown that if asbestos-containing materials are rubbed vigorously fibres are released and the amount of emission is broadly related to the fibre content and the friability of the material. The application of a surface glaze to asbestos cement reduces the emission. It must be emphasised that the categorisation of asbestos use and comparative risk given above is conjectural. The dust levels found are, in general, low and it is not easy to obtain accurate results using standard methods applicable to factory conditions. (See Appendix D.)

E5 Dust counts provided by industry on air samples taken from buildings with partitions and ceilings of asbestos insulation boards suggest that they do not release appreciable quantities of respirable fibres after they are fixed and decorated. The fibre counts for one set of samples taken at 40 locations were below 0.1 fibre/ml, and only 2 samples were above 0.05 fibres/ml. Moreover, the data show that the fibre counts tend to decrease quite rapidly with time after construction, so that none of the samples that were taken a year or more after construction contained more than 0.02 fibres/ml.

E6 With sprayed asbestos, there is an undoubted risk of the release of fibres unless the deposit is adequately sealed. The study by Lumley et al showed that where sprayed asbestos coatings in a number of storehouses were unprotected the mean dust levels could be in excess of the crocidolite hygiene standard even where there was little or no damage.

E7 Many buildings insulated with sprayed asbestos have been the subject of public concern. Some local authorities such as the county of South Glamorgan, have undertaken surveys of buildings in their ownership to discover whether the conditions of asbestos materials constitute a hazard. In some cases steps have been taken by building owners to seal or remove the sprayed insulation. One case which attracted considerable publicity was that of the Greater London Council's Pepys Estate in Lewisham, where seriously damaged sprayed asbestos insulation was discovered early in 1976. It was decided that removal was appropriate, and the building was evacuated during the process. Dust measurements taken in October 1976, after the work had been

Table E Results of airborne asbestos dust measurements carried out by 21 local authorities in United Kingdom in response to a request from the committee

	Fibre concentrations in fibres/ml									
	0–0.005 (1)	*0.005–0.010* (2)	*0.010–0.020* (3)	*0.020–0.030* (4)	*0.030–0.040* (5)	*0.040–0.050* (6)	*0.050–0.080* (7)	*<0.080* (8)	*Type of Asbestos*	*Total samples*
Birmingham	746 (98.5)	5 (0.7)	2 (0.3)		1 (0.1)			3 (0.4)	Crocidolite* (%s)	759
Rest	153 (51.1)	49 (16.4)	39 (13.0)	13 (4.4)	8 (2.0)	9 (3.0)	19 (6.4)	9 (3.0)	Crocidolite* (%s)	299
	27 (61.3)	8 (18.2)	7 (13.6)	1 (2.3)	1 (2.3)			1 (2.3)	Chrysotile (%s)	44
							1	1	Amosite	2
Total										1,102

*Although some samples were unspecified they have been assumed to be crocidolite because of location where sample taken, eg where there were sprayed Asbestos ceilings or lagged pipes.

The 21 local authorities involved and the reasons for the survey were:

	SP	SS		SP	SS		SP	SS
1 Avon	2	—	8 Harrow	22	—	15 Newcastle	4	—
2 Birmingham	—	757	9 Ipswich	1	—	16 Norfolk	4	3
3 Calderdale	16	5	10 Langbaurgh	7	—	17 Northwolds	17	—
4 Cardiff	20	77	11 Leeds	12	5	18 Sedgefield	12	—
5 Castle Point	3	—	12 Liverpool	9	—	19 South Derbyshire	6	—
6 Gloucester	2	—	13 Manchester	10	30	20 South Glamorgan	44	—
7 Gosport	3	—	14 Middlesbrough	13	10	21 Southwark	8	—

Totals
Suspected problem (SP): 215
Systematic survey (SS): 887

completed, revealed dust concentrations of the order of 0.02 fibres/ml (ie one tenth of the current hygiene standard for crocidolite). Clearly, the degree of contamination of the atmosphere in buildings depends on many factors, especially the type of asbestos-containing products that are present and their age and conditions. Following our second report the HSE laboratories are exploring new techniques for monitoring asbestos in the environment. With the co-operation of the Building Research Establishment and Greater London Council and local authorities a survey of buildings will be carried out.

E8 On behalf of the committee, a questionnaire was sent to all local authorities in 1977 inquiring about the results of measurement of airborne dust in premises under their control where asbestos was thought to be present. Twenty-one local authorities replied and the results of their reports are summarised at Table E. The results exclude the GLC whose experience is described in Appendix D para D3. It must be emphasised that these results are not derived from a systematic nationwide survey. The figures for the City of Birmingham are shown separately from the other authorities as they carried out 757 of 1102 samples taken. In Birmingham 683 dust measurements were taken in schools; the highest reading reported was not greater than 0.05 fibres/ml. Of the 345 samples taken by the rest, 215 (62%) were taken in response to a particular, suspected or actual problem; in view of this the general level of atmospheric dust encountered is probably higher than would emerge from a systematic survey of buildings but it is impossible to draw any further general conclusion. No allowance has been made for sampling times as these were not usually stated in the reports.

E9 There were 31 samples where readings for crocidolite (or unspecified fibre which may have contained crocidolite) were greater than 0.05 fibres/ml. Four of these readings were higher than the present hygiene standard for crocidolite of 0.2 fibres/ml, the highest being 0.8 fibres/ml. The details supplied are insufficient to determine the length of the sampling time or the nature of the activity or damage which gave rise to the dust. Twenty-two of the 31 samples related to deteriorating ceiling insulation in schools, homes, etc, whereas the other nine derived from a number of sources including sprayed asbestos on steel joists exposed to abrasion, and the stripping of lagging.

Appendix F

Measurements of asbestos dust concentrations outside buildings

F1 Background levels of asbestos reported in the urban environment have been measured by various techniques, most notably the membrane filter method and electron microscopy in the USA and France. Although the different methods of measurement make comparison difficult, levels around roadways would not seem to be much above levels in urban atmospheres generally except where asbestos-containing rubble is used as a road construction material.

F2 Sampling tests have been carried out by British Rail scientists to see if asbestos fibres that may be released during the application of disc brakes could enter via the air conditoning system those parts of trains used by passengers and staff. Samples were also taken in the vestibule ends and toilets in which areas the air conditioning filtration system is by-passed. The samples were taken during the course of journeys lasting between 50 minutes and 3 hours 41 minutes and where the brakes were applied between 4 to 40 times. The samples were taken with windows both open and closed and with the air conditioning damper in the open and shut positions. The result of the tests showed that very small concentrations of fibres were found in some parts of the carriages whilst in other parts no fibres were found at all. The fibres were of various types, not necessarily asbestos, and might have originated from sources such as clothing or upholstery.

F3 A study in the USA (Jacko et al 1973)[1] found that the average asbestos content of the emissions from car brakes was only 0.23%, of which only 3.7% was likely to become airborne while the rest was either retained in the brake drum or deposited on the ground. Another study (Alste et al 1976)[2] has also suggested that only a very small proportion of the emissions from brakes becomes airborne. Very high temperatures can be generated during braking and, if these exceed about 630°C, the asbestos fibres at the surface of a brake lining can lose their crystal structure and possibly decompose to form a non-fibrous silicate called forsterite. One study of the dust from brake linings confirmed this degradation [Lynch 1968][3].

F4 A study by Holt and Young (1972)[4] of the atmosphere of several towns including in this country, London, Reading and Rochdale, found asbestos fibres in every sample although in some the fibres were in bunched agglomerates. Similar studies, although on a smaller scale, have been undertaken by Rickards (Rochdale)[5] near an

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1 Byrom JC, Hodgson AA and Holmes S: *A dust survey carried out in buildings incorporating asbestos-based materials in their construction*, Ann Occ Hyg *12*, 141–145 (1969).

2 Lumley KPS, Harries PG and O'Kelly FJ: *Buildings insulated with sprayed asbestos: A potential hazard*, Ann Occ Hyg *14*, 255–257 (1971).

3 Sebastian, Bignon, Gaudichet, Dufour and Bonnaud: *Les pollutions atmospheriques urbaines par L'asbestos*. Revue Francaise des Maladies Respiratoires—supplement 2 au tome 4 1976, 51–62.

4 Nicholson WJ, Rohl AN and Weisman I: *Asbestos contamination of the air of public buildings*. Final report to the Environmental Protection Agency, Contract No 68-02-1346 (1975).

asbestos factory and Sebastian et al (1976 France)[6]. BBA Group Ltd have told us[7] that in studies undertaken by them the atmospheric concentration of asbestos fibres varies little between such sites and the environment immediately outside their factory, Gravelly Hill (West Midlands) and the Yorkshire Moors.

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1 Jacko GJ, DuCharme RT and Somers JH: *How much asbestos do vehicles emit?* Auto Engineering 81 (1973), 38–40.

2 Alste JD, Watson and Baggs J: *Airborne asbestos in the vicinity of a freeway.* Atmospheric Environment 10 (1976), 583–89.

3 Lynch RJ, 30th Annual Meeting, American Conference of Government Industrial Hygienists, St Louis, Mo. (1968).

4 Holt & Young *Asbestos fibres in the air of towns.* Atmospheric Environment 7 (1973), 481–83.

5 Rickards AL, and Badami DV: *Chrysotile Asbestos in Urban Air.* Nature, Vol 234, pp 93–94 (1971).

6 Sebastien P et al: *Les Pollutions Atmospheriques Urbaines par L'Asbeste*'. Rev fr Mal Resp Supp 2 tome 4 (1976), pp 51–62.

7 ACA: *Selected Written Evidence submitted to the Advisory Committee on Asbestos 1976–77*, HSE, (1977), p 22.

Appendix G

Practices followed in the disposal of asbestos waste and measurements of asbestos dust concentrations

G1 Recent practice in disposing of asbestos waste has been affected by three developments: the publication in 1969 of the Asbestosis Research Council's Recommended Code of Practice[1] which distinguishes six categories of waste (fine dust, small offcuts and floor sweepings etc, waste from stripping of insulating materials containing asbestos, offcuts of friable material, offcuts of high density materials and empty sacks or bags), and gives specific advice on each category; the enactment of the Deposit of Poisonous Waste Act in 1972; and the coming into force in England and Wales in 1977 of Sections 3 to 11 of the Control of Pollution Act 1974 which deal with site licensing. The combined effect of these is to impose tighter controls on the disposal of asbestos waste in landfill sites. Central government departments and local authorities concerned are broadly satisfied that these controls are observed.

G2 Before 1969 there was relatively little in the way of either published advice or legal control, and, while no doubt many of those responsible for generating large quantities of asbestos waste were careful to dispose of it safely, careless dumping also took place which has caused problems subsequently. One example described by the Metropolitan Borough of Calderdale in its written evidence to the Advisory Committee[2] is a disused tip, at which crocidolite asbestos was found to be exposed on the surface. At another site where a considerable amount of asbestos cement waste had been left indiscriminately scattered in 1958, the Factory Inspectorate in 1976 carried out measurements of dust generated by regular vehicle traffic over the site to and from a new factory built on it. Before the site was resurfaced, atmospheric concentrations of crocidolite were found well in excess of the current hygiene standard. No complete record exists of the tips where asbestos waste was deposited before the new statutory controls came into force, although most waste disposal authorities have a fairly good idea where they are or are likely to be located. The sort of problems encountered by the Metropolitan Borough of Calderdale at the Mytholmroyd Tip do not appear to be widespread.

G3 Since 1972 anyone disposing of manifestly hazardous types of asbestos waste (particularly fibrous material consisting wholly or partially of crocidolite) has been required under the Deposit of Poisonous Waste Act 1972 to notify the appropriate waste disposal and water authorities. In addition, since regulations provided for under Sections 3 to 11 of the Control of Pollution Act 1974 came into full effect on 14 June 1977, waste disposal sites in England and Wales receiving various kinds of wastes including asbestos have had to be licensed by the waste disposal authority. Furthermore, regulations will be introduced under Section 17 of the 1974 Act applying additional controls over 'special wastes', including hazardous forms of asbestos waste, which will supersede the provisions of the 1972 Act. The effect of these various statutory measures is not only that it is an offence to dispose of asbestos (and other controlled) wastes except in accordance with the terms of a valid licence, but also that the authorities have a greater amount of information available about the nature, quantity and location of asbestos waste deposited. When the proposed regulations under Section 17 are made, controls will be even tighter.

G4 A Department of the Environment Waste Management Paper No 18 'Asbestos Wastes, a Technical Memorandum on Arisings and Disposal including a Code of Practice' was published by HMSO in May 1979. This Code of Practice updates and replaces 'Part II Disposal of Asbestos Waste Materials: Tipping Practice' of the ARC Recommended Code of Practice first published in 1969 and revised in 1973. The main recommendation is that all the asbestos waste should be deposited at the foot of the working face and should, by the end of the working day, be covered with other waste on the site to a depth of about two metres and then with consolidated earth or other suitable material capable of forming a seal to prevent subsequent interference and dispersal of dust. It is also recommended that no waste should be left uncovered at the end of a working day. The document aims to avoid the generation of respirable dust, so it is recommended that waste material wherever practicable be put into impermeable sacks or receptacles except off-cuts and large pieces of waste of high density products, where dust emission is negligible (such as asbestos cement off-cuts and waste sheets) which would require further breaking down to reduce to manageable size before such disposal. The document points out that where the waste material consists of, or contains, crocidolite, the bags or receptacles must be marked in accordance with the Asbestos Regulations 1969 to state, 'blue asbestos – do not inhale dust'.

G5 Sixty-one of the sites investigated by HMFI, during 1976 and 1977 were private, 56 belonged to waste disposal authorities and 16 were within the curtilage of asbestos product manufacturing plants. The ARC Recommended Code of Practice was being followed at 96 of the 115 sites at which landfilling was taking place at the time of the Factory Inspector's visit. Atmospheric dust sampling was carried out at 79 of the sites, and 236 samples taken: 25 % in the breathing zone of the worker, 65 % in the background and 10 % outside the site perimeter. The following table shows the results of the samples taken:

Table G1 Distribution of personal, background, and beyond site boundary samples

Range of asbestos concentration in air (fibres/ml)	*Number of personal samples*	*Number of background samples*	*Number of samples beyond site boundary*
Less than 0.01	1 (1)	1 (1)	2 (2)
0.01–0.2	48 (6)	147 (6)	21 (5)
0.21–0.4	3 (–)	1 (–)	1 (–)
0.41–0.6	*2 (1)	—	—
0.61–0.8	4 (–)	—	—
0.81–1.0	—	—	—
1.01–1.2	—	—	—
1.21–1.4	—	—	—
1.41–1.6	—	—	—
1.61–1.8	1 (–)	—	—
1.81–2.0	—	1 (–)	—
Greater than 2.0		†3 (1)	—
Total	58 (8)	153 (8)	24 (7)

(*Note:* Figures in brackets represent those samples included in the main figures which contain a proportion of crocidolite.

Hygiene standards: 2 Fibres/ml for non-crocidolite; 0.2 Fibres/ml for crocidolite.

*Actual value for the crocidolite sample was 0.6 fibres/ml.

†Actual value for the non-crocidolite samples were 2.3 and 2.4 fibres/ml and for the crocidolite sample, 8.6 fibres/ml.)

G6 The table shows that 2 non-crocidolite samples exceeded the 2 fibres/ml hygiene standard. One of these samples with a reading of 8.6 fibres/ml may be explained by the fact that split bags were observed spilling their contents on the site where the sample was taken. None of the samples taken beyond the site boundary yielded figures in excess of the hygiene standard.

1 Asbestosis Research Council: *Recommended Code of Practice for the Handling and Disposal of Asbestos Waste Materials, 1969* (Revised 1973).

2 Selected Written Evidence Submitted to the Advisory Committee on Asbestos, 1977, pp 91–92.

Appendix H

Labelling of consumer products containing asbestos

H1 This Appendix has been prepared by the Department of Prices and Consumer Protection (now the Consumer Safety Unit of the Department of Trade) to describe the labelling scheme for consumer products containing asbestos which they oversee.

BACKGROUND TO THE VOLUNTARY LABELLING SCHEME

H2 The underlying reasoning behind the scheme is that consumers should be informed of any product which contains asbestos, so that this can be taken into account in selecting which products to purchase. It seems reasonable to think that the usefulness of this information will be increased if it includes some brief indication of the nature of the hazard and ways of minimising the risk.

H3 The voluntary labelling scheme was introduced in October 1976 following discussions between DPCP, HSE, the then Asbestos Information Committee (representing industry) and the Asbestosis Research Council. Because of the practical difficulties in providing all the information with the product itself, it was decided to use a brief cautionary message, supplemented by a leaflet to be issued by the retailer to each customer. In some cases the message is stamped on the product but more usually it is printed on a label affixed by adhesive to the product or its wrapper.

H4 The scheme applied to all UK manufactured asbestos-containing products and waste which could, under any foreseeable circumstances, constitute a possible danger to health through release of asbestos dust whether at work or in the home. The following consumer and DIY goods were specifically listed for inclusion in the scheme:

Oven gloves
Oven door replacement seals
Ironing board replacement rests
Simmering pads
Wall plugging compounds
Brake linings
Insulation board
Cement sheet

More recently the industry has sought to persuade importers of these products to participate in the voluntary labelling scheme. DPCP fully supports this action. Consideration has also been given to the inclusion of certain types of floor coverings in the scheme. However, the asbestos content of these products is usually well bonded with other materials and, in the case of tiles sold individually, it would be necessary to label every tile. For these reasons DPCP has not pressed for these products to be brought into the arrangements.

EFFECTIVENESS OF THE LABELLING SCHEME

H5 The industry has commissioned MAS Survey Research Limited to conduct two main surveys of the retail trade's awareness of the labelling and leaflet scheme and its performance. The first of these was based on fieldwork undertaken in February 1977 (only a few months after the commencement of the scheme) and the second in November 1977. A subsidiary survey restricted to insulating boards and cement sheeting was conducted in May 1978. DPCP are arranging for further surveys to be conducted.

H6 The main surveys were conducted on a sample of some 230 retail outlets covering representative groups of department stores, motor accessory shops, chemists, variety stores and hardware stores. The researchers found in the second survey that there had been some improvement in the proportion of labelled goods available in the shops. This is illustrated in the following table:

	Feb '77 %	*Nov '77* %
Ironing board replacement rests	5	20
Simmering pads	11	33
Wall plugging compounds	53	69
Brake linings	30	48

Insufficient numbers of stores which stocked oven gloves and door seals were found to enable significant calculations to be made. As regards insulation boards and cement sheets, since these are largely sold by builders merchants and roofing contractors, which were not included in the scope of the survey, the results for those products also carry very little weight. It was for this reason that the subsidiary survey was commissioned. 145 visits to builders' merchants and roofing contractors in May 1978 indicated that 56% were then stocking labelled insulation board and 50% had labelled cement sheets.

H7 In assessing the impact of the labelling scheme, it has to be borne in mind that some of the products are slow turnover goods. Not all the outlets had received new supplies in the period immediately preceding the survey; the proportions of labelled goods therefore reflect the supply position at a considerably earlier date. It is also thought that these products are often sold out of rotation and therefore very old (unlabelled) stock may remain on the shelf to affect the results of any survey. In fact, of course, it is actually desirable that newly delivered, labelled goods should be sold to the customer, while unlabelled goods remain in stock.

H8 A further difficulty in interpreting the results of the surveys lies in the fact that it is quite impossible for a researcher to determine whether all or only the part of a store's stock of, say, insulation board is labelled. The percentages quoted in para H6 above therefore relate to outlets where some labelled examples of the product in question were found. It may be that the proportions are understated due to the inability of research visitors to inspect all the stock.

H9 It must also be remembered that while the labelling scheme was only being applied to domestic manufacture, the surveys covered both imported and UK produced goods. There are indications that recent efforts to persuade importers to join the scheme are achieving satisfactory results. We are informed that over half of the importers contacted are now labelling and that the majority of the remainder have agreed to join the scheme.

H10 It seems reasonable, therefore, to conclude that, while the labelling situation cannot yet be regarded as satisfactory, there is good reason to hope that by the end of 1978 up to 80% of all the listed consumer products reaching retail outlets will be labelled. It remains to be seen whether further improvement will be possible and if the industry's commitment to the scheme can be maintained indefinitely.

AVAILABILITY OF LEAFLETS

H11 So far as the complementary leaflet scheme is concerned, the surveys show the position to be much less encouraging. Safety precaution instructions are being included with some products but the distribution of leaflets by retailers has proved quite ineffective. Only a negligible number of stores had the leaflets in stock when last visited and still fewer actually gave them out to customers. This therefore undermines the value of all the hard work put into the labelling side of the voluntary arrangements.

CONCLUSIONS

H12 In this essentially dynamic situation, with many factors making it difficult to measure the effectiveness of the operation, DPCP does not consider it appropriate to use the results of the surveys other than as a general guide. The department has continued to encourage the industry to take steps to improve the coverage of the labelling scheme but sees no prospect of obtaining marked improvement in the issue of leaflets. It is accepted that even 100% labelling would achieve little more than identification of the presence of asbestos. It is a matter of opinion as to whether consumers would observe the safety advice given in the leaflets but the Department receives few enquiries on this subject.

H13 If so, this is entirely understandable. It appears to the layman that most of these consumer products are unlikely to release asbestos fibres in significant quantities in normal use. Subject to any evidence to the contrary, DPCP believes that only those products which may be sawn, cut, drilled, sanded or otherwise worked present a real risk to the consumer. In practical terms, concern can probably be limited to wall plugging compounds, insulation boards and cement sheets. The latter two items probably constitute the greatest risk because of the quantity of asbestos materials involved and they are presumably produced mainly for use by the construction industry. DPCP therefore has a relatively minor interest in these products and must take account of the views of those responsible for their industrial use.

Appendix J

An examination of asbestos in relation to food and drink

SUMMARY OF FOOD ADDITIVES AND CONTAMINANTS COMMITTEE'S RECOMMENDATIONS

(*Note:* Paragraph numbers refer to relevant paragraphs in the FACC Report)

J1 all possible action should be taken to ensure that asbestos fibre contamination of drinking water, beverages, and food is reduced to a minimum (paragraph 6);

J2 every effort should be made by all users of asbestos-containing filters in the food and beverage industries to find a suitable alternative material (paragraph 16);

J3 wherever in a food-processing plant there is use of a component or product which contains asbestos and which may release fibres through abrasion or by any other means, suitable toxicologically acceptable alternative materials should be used wherever possible (paragraph 17);

J4 work should continue, and new research should be encouraged by the food industry towards the development of materials to replace those containing asbestos, and practices which involve the use of asbestos should cease as soon as suitable alternatives are available (paragraph 17);

J5 the relevant authorities should be made fully aware of the possibility of contamination of foodstuffs with asbestos as a result of spillage or of inadequate cleaning of ships' holds which had previously been used for carrying asbestos (paragraph 19);

J6 a specific statutory control for asbestos in materials and articles in contact with food should not be introduced (paragraph 31);

J7 a statutory maximum permitted level of asbestos in food should not be introduced (paragraph 32).

Medical effects

3

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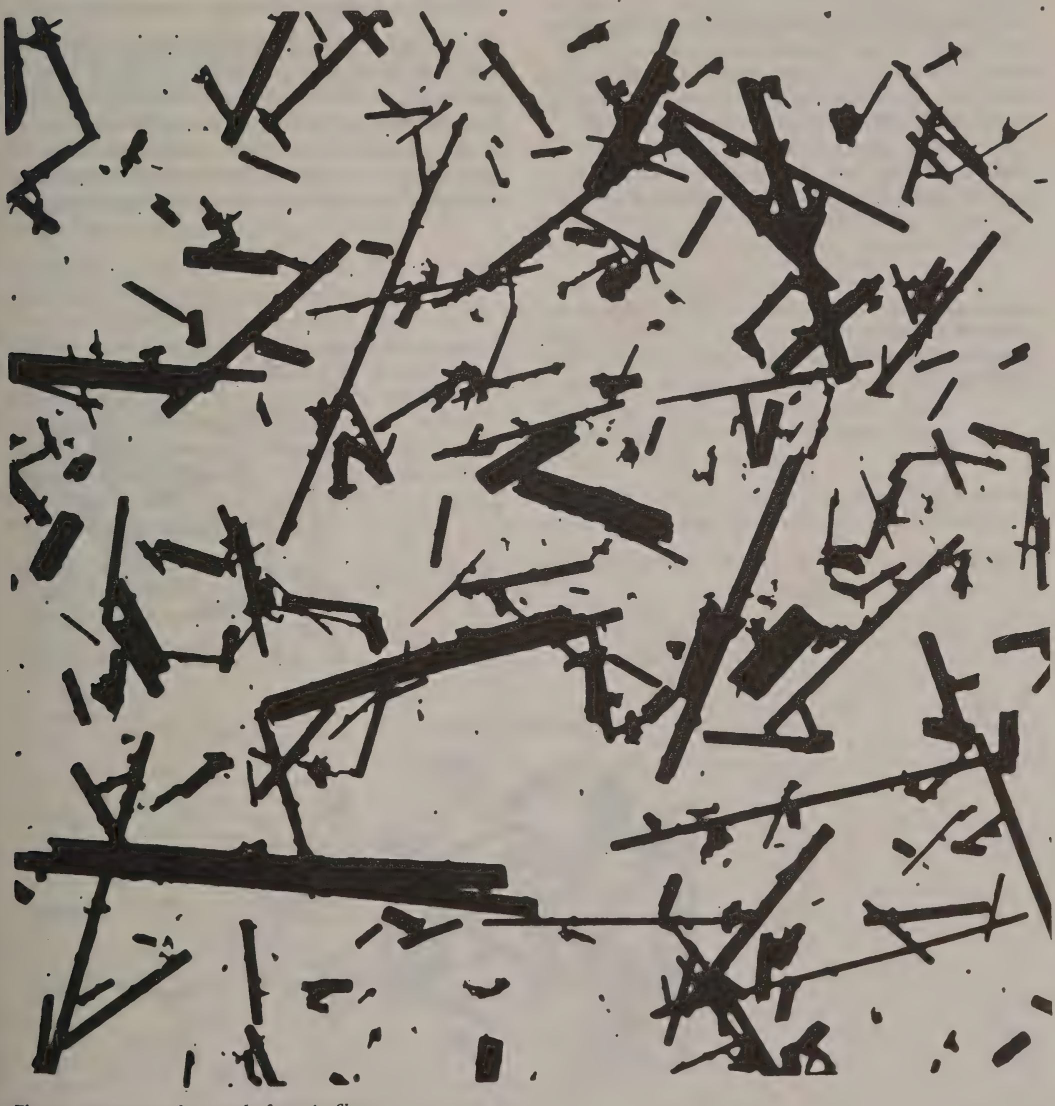


Electron miscroscope photograph of amosite fibres

61 This chapter is an agreed summary of the principal points from the report prepared for the committee by Professor Acheson and Dr Gardner. The full text of their report is in Volume 2. In dealing with such matters it is difficult to avoid the use of words and concepts which are essential for accuracy but may be unfamiliar to the general reader, so Appendix K provides a short glossary of some of the terms employed here. Figures and Tables in this chapter are cross-referenced to their counterparts in Volume 2.

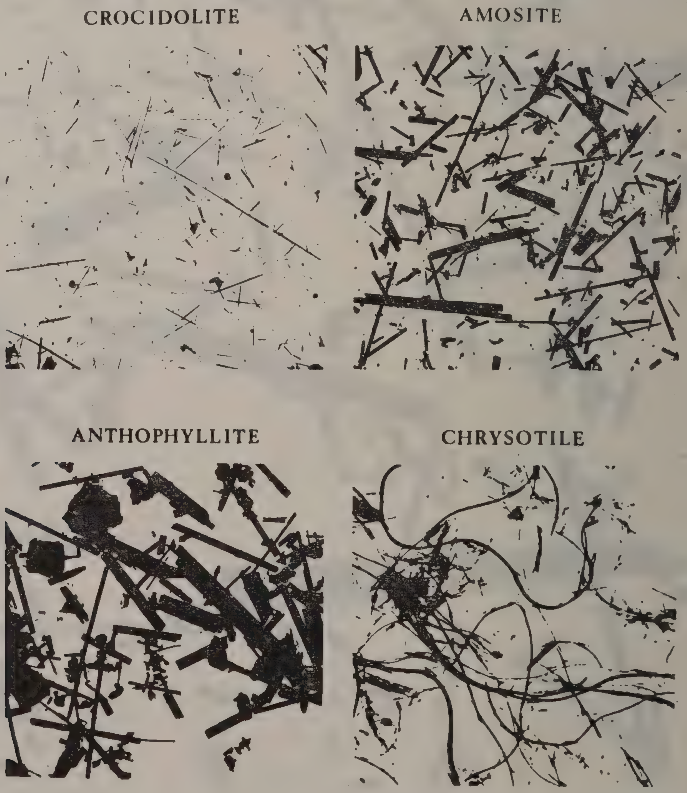
Biophysics of asbestos

62 The properties of asbestos fibres which determine their commercial and biological interest were outlined earlier: their capacity to split longitudinally into finer fibres; their insolubility and resistance to destruction by heat, acids and alkalis; their effectiveness as thermal, electrical and acoustic insulating material; and their ability to be woven. Once embedded in animal tissues some of the fibres remain within the body for extended periods of time; the proportion remaining being higher for amphiboles than for chrysotile.

63 As the likelihood of a fibre to remain airborne or to settle is determined by its diameter, and the number of fibres per unit mass is greater in the case of finer fibres, it is clear that fibre diameter is the key to the number of fibres inhaled. For a given mass of airborne amphibole dust the number of fibres available for inhalation at a given moment and the length of time the dust cloud remains airborne is greater for crocidolite than for amosite and for amosite than for anthophyllite. For chrysotile, which has a greater tendency to divide into fibrils than the amphiboles, the aerodynamics of the dust will depend to a greater extent on the amount of milling or grinding so its respirability may be similar to that of the amphiboles in some circumstances.

64 Once inhaled, the depth of penetration of asbestos fibres depends upon the lengths and diameter of the fibres and upon their straightness. Fibres longer than about 200 micrometres (μm) are largely filtered out in the nasal passages, from which they are cleared and predominantly swallowed. Some of the fibres are shorter than about 10μm which penetrate deep into the lung,

Fig 2 (see Vol 2, Fig 3). Appearance of asbestos fibres under the electron microscope (10μm) (Biol. effects p296) (Timbrell 1973)[1]


CROCIDOLITE

AMOSITE

ANTHOPHYLLITE

CHRYSOTILE

are probably transported by macrophages to the mucociliary escalator of the respiratory passages and cleared from the lung to be subsequently swallowed. The fate of the remaining fibres is thought to depend upon diameter, length and possibly straightness. Animal experiments show that, for reasons not fully understood, much less chrysotile than amphibole fibre remains in lung tissue after inhalation has ceased.

65 Fibres of a wide range of chemical structures (including substances as diverse as glass and aluminium oxide as well as asbestos) have been shown to produce mesothelioma after injection into the pleural or peritoneal cavities in animals if the configuration of the fibres falls within a certain range. Experiments showed that for asbestos, glass fibre and aluminium oxide the degree of carcinogenicity is related to the proportion of fibres with diameters between 0.5 and 2.5μm and lengths 10-80μm. In later experiments using glass fibre only the highest incidence of tumours occurred with fibres up to 1.5μm in diameter, including very thin fibres of diameter less than 0.25μm and of length greater than 8μm. It is important to point out that 0.5μm represents the approximate limit of light microscopy in respect of fibre diameter.

66 So although the doses administered were very large indeed and the results of intrapleural implantation of fibres in rats cannot be used as a reliable predictor of risk to man through inhalation, these experiments strongly suggest with the current optical methods the total number of respirable fibres will have been under-estimated but to a similar degree in different types of exposure, so that our conclusions about relative risks are not significantly affected. However there must remain uncertainty about this. The development of methods which measure the whole range of respirable fibres is urgently needed.

Asbestos-related disease, portals of entry and types of exposure

67 *Asbestosis*, which may be defined as fibrosis of the lungs caused by asbestos dusts which may or may not be associated with fibrosis of the parietal (outer) or pulmonary (inner) layer of the pleura, lung cancer (carcinoma of the bronchus), and mesothelioma of the pleura and peritoneum are universally accepted as diseases with a causal relationship to the inhalation of asbestos fibre. Benign pleural effusion (fluid developing in the space between lung and chest wall) may occur acutely in association with other asbestos-related lung diseases or as the only or most prominent disease process. It may be discovered by accident or associated with pain, fever and malaise. Thickening of the pleura may occur, alone or in association with fibrosis of the lung, and may be symptomless or associated with chest discomfort and restriction of breathing.

68 Asbestosis, which by definition is specifically related to asbestos, is difficult to diagnose because its onset is gradual, and because the symptoms and signs may occur in other diseases and are often difficult to detect. Minor changes in x-ray pictures attributable to asbestos may exist for many years without symptoms or progression.

69 *Lung cancer* is easier to diagnose than asbestosis but the tumours which occur in relation to asbestos have no special diagnostic feature. As tobacco-related lung cancer is common and the effects of tobacco and asbestos are known to interact synergistically in smokers exposed to asbestos, it may be impossible to determine in a particular case whether or to what extent a bronchial tumour is related to asbestos.

70 In the case of *mesothelioma*, although there are also diagnostic problems, the position at present is that the

Table 10 (see Vol 2 Table 3a) Cancer of the gastro-intestinal tract and peritoneal mesothelioma in 8 surveys (including 2 studying two different sub-populations) in which an excess of the former has been reported.

Reference	*Population*	*Cases Observed (O)*	*Cases Expected (E)*	*O/E*	*O–E*	*Peri.mes.*	*Fibre* Type*
Selikoff[2]	Insulators	43	13.6	3.15	29.4(S)‡	25	C & A
Elmes & Simpson[3]	Shipyard workers	15	5.2	2.91	9.8(S)	0	Cr, C, A
Selikoff[4]	Amosite workers	26	12.5	2.07	13.5(S)	6	A
Enterline[5]	Maintenance workers	22	13.3	1.65	8.7(S)	0†	C, A & Cr
Selikoff[4]	Insulators	61	37.8	1.61	23.2(S)	63	C & A
Newhouse[6]	Insulation manufacturers	31	20.4	1.52	10.6(S)	15	C, A & Cr
Mancuso[7]	Production workers	16	10.6	1.51	5.4(NS)	6?	?
McDonald et al[8]	Thetford miners and millers	165	144.8	1.14	20.2(NS)	0	C
Enterline[5]	Production workers	37	32.5	1.14	4.5(NS)	0	C
McDonald et al[8]	Asbestos miners and millers	125	150.4	0.83	—25.4(NS)	0	C
Peto et al[9]	Textile workers	16	15.7	1.03	0.4(NS)	0	C & ? Cr

*A = Amosite; C = Chrysotile; Cr = Crocidolite.

†It is known tht many cases of mesothelioma occurred in younger men in this factory.

‡(S) = significant excess ($P<0.05$) (NS) = no significant excess ($P>0.05$).

Table 11 (see Vol 2 Table 3b) Observed and expected deaths from cancer and from all other causes in insulation workers and amosite insulation material operatives.

	New York/New Jersey insulation workers		*US and Canadian insulation workers*		*Amosite insulation material operatives*	
Cause of death	*Obs*	*Exp*	*Obs*	*Exp*	*Obs*	*Exp*
Total cancer: all sites	189	47.2	459	144.1	143	50.2
Lung cancer	84	10.1	213	44.4	73	11.4
Pleural mesothelioma	8	—	26	—	3	—
Peritoneal mesothelioma	24	—	51	—	4	—
Cancer of stomach	41	13.0	16	6.6	11	4.6
Cancer of colon, rectum			26	17.5	15	7.1
Cancer of oesophagus			13	3.2	0	1.2
All other cancers	32	24.1	114	72.3	37	25.9
All other causes	199	232.8	555	661.5	314	249.3

Source: Selikoff et al, 1973[10]

*20 or more years after first exposure to asbestos.

Table 12 (see Vol 2 Table 3c) Evidence for an association between asbestos inhalation and laryngeal cancer.

Study		*Cases*	*Controls*	*Relative risk*
Stell and McGill	11	31/100	3/100	14.5
Insulation workers		19	3	
Dockers		9		
Boiler scalers		3		
Shettigara and Morgan	12	10/43	0/43	—
Insulation workers		4	0	
Cement workers		3		
Sprayer		1		
Others		2		
Newhouse and Berry	13	2	0.4*	5.4
Selikoff	14	9	4.5*	2
McDonald et al	8	16	15*	1.07

*Expected deaths.

disease is one of the rarest malignancies in the population at large and that asbestos is the only environmental cause of the condition in the United Kingdom so far identified, smoking having no effect.

71 All the asbestos related diseases mentioned above have in common the existence of a delay or lag-period, usually of many years, between first exposure and onset of symptoms. This has a number of serious implications of which the most important are that the disease may occur many years after the worker has left the relevant job; cases of the disease occurring at present do not relate to current conditions of work; and a period of several decades must elapse before it is possible to give a final answer about the appearance or control of an asbestos related hazard.

72 The evidence for the existence of a risk of *cancer of the gastro-intestinal tract* associated with exposure to asbestos was discussed (Tables 10 and 11) and it is concluded that, although an excess of gastro-intestinal cancer has not been found in all surveys, substantial excesses are seen in surveyed industrial populations in which workers have been exposed to mixtures of asbestos rich in amphiboles and in the only population formally studied thought to have been exposed only to amosite. There is insufficient pathological information concerning the accuracy of diagnosis in deaths ascribed to cancer of the gastro-intestinal tract. It is not improbable that some of these deaths are due to misdiagnosed peritoneal mesotheliomas. It is also concluded that there is evidence of a risk of *cancer of the larynx* in association with the inhalation of mixtures of asbestos containing amphiboles, but that this risk is very much smaller in absolute terms than the risk of any of the conditions mentioned above. (Table 12.) In one study of the relationship between chrysotile exposure and cancer, no evidence was found of an increased risk of cancer of the larynx.

The relative order of frequency of the types of asbestos related disease

73 By summing the experience of the various industrial populations which have been followed in different parts of the world (Table 13) it is possible to compare the relative importance of the mortality of the different types of asbestos related disease as they have occurred in men exposed to the industrial conditions of the past. The excess mortality found in these studies is accounted for in order of importance by lung cancer (associated or not

Table 13 Mortality from selected causes in the principal published industrial cohorts for which data are available

Cause of death	*No of deaths*	*Study* 1	2	3	4	5	6§	7	8	9	10	11**
All causes	O	754	3 291	317	350	524	451	1 358	248	98	655	281
	E	657	3 015	249	268	319	305	960		38	527	134
	O–E	97	276	68	82	205	146	398		60	128	147
	O/E	1.15	1.09	1.27	1.31	1.64	1.48	1.41		2.61	1.24	2.09
Cancer of lung	O	58	230	51	63	84	89	275	21	26¶ (28)‖	46	30
	E	22	184	24	24	13	12	56	13	1.6¶	19	17
	O–E	36	46	27	39	71	77	219	8	24.4¶ (26.4)‖	27	13
	O/E	2.7	1.2	2.1	2.6	6.3	7.3	4.9	1.7	15.9¶ (17.1)‖	2.4	1.8
GI cancer	O	53	276	16	31	26*	43*	61	7	15	36	16
	E	42	272	16	20	13*	14*	38	15	5.2	29	11
	O–E	11	4	0	11	13*	29*	23	†8	9.8	7	5
	O/E	1.3	1.0	1.0	1.5	2.1*	3.2*	1.6	0.5	2.9	1.2	1.5
Mesothelioma	O (ple)	1	8(10)‖	10	9	5	10	29	0	1(4)‖	0	1
	O (per)	0 (0.1%)	0(1)‖ (0.2%)	0 (3.2%)	15 (6.9%)	6 (2.1%)	22 (7.1%)	63 (6.8%)	0 (0.0%)	0(3)‖ (1.0%)	0 (0.0%)	6 (2.5%)
Asbestosis	O	18 (2.4%)	42 (1.3%)	25 (7.9%)	12‡ (3.4%)	27 (5.2%)	37 (8.2%)	101 (7.4%)	13 (5.2%)	9 (9.2%)	52 (7.9%)	31 (11.0%)

Source: 1 – Enterline (C, A, Cr) 5,15; 2 – Quebec (C) 8; 3 – Rochdale (C, ? Cr) 9,16; 4 – Newhouse (C, A, Cr) 6; 17 – Selikoff (A) 4; 6 – Selikoff NY (CA) 2, 4; 7 – Selikoff US+ Canada (C, A) 4; 8 – Finland (An) 18; 9 – Elmes (Cr, C, A) 3; 10 – Wagoner (Cr) 19; 11 – Mancuso (?) 7.

O = Observed E = Expected

*Stomach + colon + rectum †abdomen ‡based on later data §only includes men 20+ years in industry ¶including larynx ‖figures in brackets are after revision of death certificate diagnosis **observed deaths in men with 2+ years employment; expected deaths based on experience of men with less than 2 years employment.

Types of fibre to which the men were exposed are shown in brackets.

Note: This table is an overall summary of mortality experience in each study and does not for example consider relative dust exposure of the different populations. The problems of comparability are discussed in Vol 2.

associated with asbestosis), asbestosis, mesothelioma and gastro-intestinal cancer. Included in this excess mortality for lung cancer is a substantial element due to the synergistic action of tobacco with asbestos, which cannot therefore properly be attributed to the effect of asbestos alone. These studies indicate the relative importance of lung cancer, asbestosis and mesothelioma in relation to the effects of past asbestos exposure and in the cigarette smoking patterns. The frequency of these diseases in the future will depend not only on control of exposure to asbestos dust but also upon future trends in cigarette smoking.

74 The study of British death certificates suggests a different picture, namely that asbestos-related mesothelioma is a more frequent cause of death than asbestos-related lung-cancer. However, death certificates (Table 14) are probably an unreliable indicator. For example, the mention of asbestos on death certificates of people dying from lung cancer who were smokers and who were also exposed to asbestos is almost certainly deficient.

MEANS OF ENTRY

75 Although by far the most important means of entry of asbestos fibres to the body is the respiratory passages, the fibres may also be swallowed by the ingestion of contaminated water or food or by swallowing contaminated nasal or bronchial secretions. Accidental administration of asbestos may also have taken place from the use of syringes, drugs and medicaments containing asbestos.

TYPES OF EXPOSURE

76 Direct occupational exposure as illustrated in Chapter *1* includes exposure during mining and milling, transporting, packing and processing raw fibre, installing adapting and working on new products, repairing and servicing existing products, demolishing buildings and vehicles containing asbestos products, and dumping asbestos-containing waste.

77 Indirect occupational exposure (to persons working in the vicinity of men handling asbestos), domestic exposure (to domestic contacts, eg wives and children of asbestos workers), leisure time exposure, neighbourhood exposure and general exposure (through the air, food or water supplies) also occur in appropriate circumstances, and a proportion of the fibres present in the environment, particularly in water, may derive from deposits of asbestos in other rocks and ores.

The relationship of medical effects to fibre type

ANIMAL EXPERIMENTS

78 Experimental work in animals shows that inhalation of similar respirable masses of standardised research samples of chrysotile produces at least as many malignant lung tumours and mesotheliomas as do standardised research samples of the amphiboles. Furthermore in pleural implantation experiments chrysotile, when the configuration of the fibres is appropriate (ie superfine (SFA) Canadian chrysotile), produces as high a yield of mesotheliomas as crocidolite. However using asbestos (prepared by hammer milling) which probably resembles more closely that used in the past by industry, similar respirable masses of chrysotile and amosite have been found to be less carcinogenic than crocidolite.

LUNG CANCER IN MAN

79 Evidence in man about the relationship of fibre type to lung cancer is inconclusive, but where it exists it indicates that exposure to the amphiboles crocidolite or amosite (or to mixtures with chrysotile rich in them) has been more dangerous than to chrysotile or antho-

Table 14 (see Vol 2 Table 20) Death certificates mentioning mesothelioma, etc, Great Britain, 1967–76

Year of death	*Mesothelioma*	*Lung cancer with mention of asbestosis or asbestos exposure*	*All certificates mentioning asbestosis*
1967	88	34	60
1968	153	25	81
1969	159	25	77
1970	193	24	80
1971	176	32	78
1972	208	40	103
1973	218	41	102
1974	221	41	120
1975	256	49	163
1976	292		

Source: Health and Safety Executive, 1977

Table 15 (see Vol 2 Table 21) Relative risk of death from respiratory cancer by type of fibre, corrected for differences in cumulative dust exposure (in million particles per cu ft years). After Enterline and Henderson (1973)[20]

Type of fibre	*Respiratory cancer deaths*	*Average cumulative dust exposure*	*Relative risk adjusted for cumulative dust exposure*
Amosite only	4	330	3.9
Chrysotile only	39	244	2.4
Amosite and chrysotile	3	266	1.7
Chrysotile and crocidolite	10	209	5.6
Amosite, chrysotile and crocidolite	2	273	2.4
Any amosite	9	286	2.5
Any chrysotile	54	244	2.6
Any crocidolite	12	229	4.4

Table 16 (see Vol 2 Table 28) Observed to expected ratios for death from lung cancer 30 years after onset of work in an amosite factory. Men recruited during the years 1941–45

Length of time worked	*Number of men*	*Observed to expected ratio of deaths after 30 years*
< 1 month	65	2.5
1 month	101	2.4
2 months	101	3.5
3–5 months	165	1.8
6–11 months	148	3.4
1 year	130	5.1
2+ years	199	7.2

Source: Seidman et al[21]

phyllite alone (Table 15). However, as important gaps in our knowledge of this aspect of the field remain unanswered, the weight which can be attached to this conclusion at present is limited. The high relative risks of lung cancer reported in a single study of workers making insulation material containing amosite even after very short exposure is worrying in view of the increase in utilisation of this material in the United Kingdom since the War (Table 16). There is no reliable information from South African amosite miners to help us on this point. We conclude that a firm judgment on the question whether amosite has been more dangerous than chrysotile in respect of lung cancer is not possible at present and that further work should be commissioned urgently.

ASBESTOSIS IN MAN

80 Quantitative evidence about impairment of lung function in man in relation to fibre type is limited to one study which suggests that crocidolite may have been more harmful than chrysotile. Information from the same amosite insulation manufacturers as were mentioned in connection with lung cancer, and their families, shows that radiological changes suggestive of asbestosis occurred after relatively short exposures. Evidence for a difference in risk of asbestosis with fibre type is at present slight.

MESOTHELIOMA IN MAN

81 As far as mesothelioma is concerned, evidence from miners; from process workers exposed to a single fibre type; from the distribution of neighbourhood and domestic cases; and from the geography of mesothelioma, when combined, presents a powerful case from four different sources that crocidolite has been more dangerous than chrysotile and anthophyllite. The position of amosite may be intermediate between crocidolite and chrysotile. There is no doubt that some crocidolite was used at Rochdale, but the significance of this as a cause of the mesothelioma cases there is not certain. It can be concluded that exposure to chrysotile alone has rarely been shown to cause mesothelioma.

82 The death rate from mesothelioma as certified on death certificates in Britain, although small in absolute terms, has doubled in the decade 1967-76, (Table 14 and Fig 3). Although this trend may be affected by a recent tendency to diagnose mesothelioma more readily, the evidence concerning occupational dust exposure conditions in earlier years (to which deaths occurring at present are mainly due) suggests that the number of deaths from mesothelioma may be expected to increase further before the peak is reached.

CANCER OF THE GASTRO-INTESTINAL TRACT IN MAN

83 Significant excesses of cancer ascribed to these sites have occurred in most populations of industrial workers heavily exposed in the past to mixtures of amphiboles with chrysotile and in one population thought to be exposed exclusively to amosite. The evidence that exposure to chrysotile alone has increased the risk of gastro-intestinal tract cancer is less consistent (see Table 10).

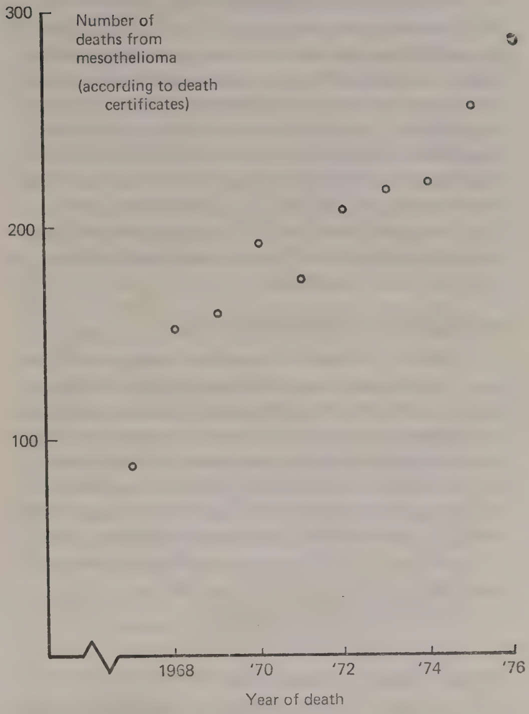


Fig 3 (see Vol 2 Fig 17) Death certificates mentioning mesothelioma. Great Britain, 1967–76 by year.

CHANGES IN INDUSTRIAL PRACTICE

84 Inhalation experiments in animals show that all fibre types of asbestos have the potential to produce similar amounts of the main types of asbestos related disease if the physical configuration of the fibres in the dust is appropriate. Intrapleural injection experiments also show that finely divided chrysotile can be prepared in such a way that it produces a similar number of mesotheliomas to crocidolite. It follows that any change in industrial practice in the direction of the production of more finely divided chrysotile fibre is likely to increase the health risk.

Dose-response relationships

85 The incidence and severity of the pathological response to increasing doses of asbestos in man is crucial to framing a rational policy about an acceptable level of exposure. Thus, if there were a level of dose below which no risk of sickness or death is incurred (ie a threshold) at least such a level would be acceptable. In contrast, if it could be shown that the largest increments in risk per unit of exposure occurred at the lower end of the range of dose, a policy of very strict control might be indicated.

86 For a number of reasons which are given in detail in the section on dose response relationships in Volume 2 the available measurements of dose and of response are subject to considerable error and uncertainty. As a result there is plenty of room for differences of opinion about the validity of the conclusions reached in this section. From paras 92-94 we set out our conclusions about the dose-response relationships which can be demonstrated from the available data based on the experience of industrial populations. But first we consider one of the most important sources of uncertainty, namely the problems of dust estimation.

PROBLEMS OF DUST ESTIMATION

87 To draw conclusions about dose-response relationships, we must be able to relate the frequency of disease with dust measurements. But methods of measuring dust have differed from time to time and from place to place, and relating measurements arrived at by the different methods is not straightforward. A detailed account of the problem was given in our Second Report and a further discussion is presented by Dr J Steel in Volume 2. Here, we restrict ourselves to summarising the main sources of uncertainty, so as to make it clear why many of our later conclusions must be tentative.

88 Factors which may vary are:

(a) the sampling instrument used;

(b) the location of the sampling instrument relative to the workman;

(c) the nature of the dust counted (all particles, or fibres only);

(d) the evaluation technique.

89 The standard sampling instrument most commonly used in Britain today is the membrane filter sampler. But before 1964 the commonest instrument was the thermal precipitator, while in the USA and Canada many of the data are derived from midget impingers. Membrane filters are used to count fibres, while midget impingers can only be used to count total particles, and thermal precipitators can be used to count fibres only very inaccurately. There are considerable uncertainties in converting particle counts (particularly from the impinger) to fibre counts, as correlations are poor. Before 1970, membrane filter sampling was typically static, with the instrument in a fixed position in the workplace. Since 1970, personal sampling has become more common. Studies have shown that personal sampling increases the number of fibres counted in a given workplace by a factor which varies widely both within and between manufacturing processes, but which, at dust levels around 2 fibres/ml, is probably between 1 and 2 (see Table 17).

90 The results of fibre counts are affected by the method of counting used. The current method of 'eyepiece graticule' counting has been introduced since 1969. When compared with the older 'whole field' counting technique, graticule counting increases fibre counts by a factor which has been estimated as being of the order of 2-3 (see Table 17).

Table 17 (see Vol 2 Table 37) Conversion factors for measurements of asbestos dust concentrations

Source	*Modern counting techniques/old counting techniques*	*Personal sampling/ static sampling*
Holmes [22]	2 : 1	1+ : 1
Steel [23]	2.5 : 1	2 : 1

91 The combined effect of these last two factors means that an atmospheric chrysotile concentration which would have been evaluated as 2 fibres/ml in 1968 might well today be evaluated as somewhere between 4 and 10 fibres/ml. Alternatively, a concentration measured today as 2 fibres/ml might have been measured as between 0.4 and 1 fibre/ml in 1968. So it follows that these changes in sampling and evaluation techniques have brought about a de facto tightening of the hygiene standard since 1969.

ASBESTOSIS

92 The signs of developing asbestosis are much less reliable as objective end points than is the occurrence of a malignant tumour. Not only are there major difficulties in the definition of asbestosis of sufficient severity to cause symptoms, but the clinical, radiological and other signs on which the diagnosis is based are non specific and subject to wide variations in interpretation. Furthermore, at present comparatively little is known about the progression of the condition particularly in the stages before symptoms have developed.

93 A study which permits estimates of the occurrence of new cases of asbestosis to be related to dose is the second report from Rochdale[24]. Although they are all somewhat irregular in form, the responses of the three parameters studied (certified asbestosis; possible asbestosis; and crepitations) are directly proportional to the cumulative dose (Fig 4). For certified asbestosis, as might be expected, there appears to be a threshold at an estimated cumulative dose somewhere between zero and 100 fibre years per ml below which certification has not taken place. However an annual incidence of 0.5% (Standard error (SE) 0.2%) of certified asbestosis has occurred after cumulative doses of less than 100 fibre years per ml, ie within a working life of 2 fibres per ml. The annual rates of incidence for 'possible asbestosis' and 'crepitations' are higher at any given dose level and suggest the possible occurrence of asbestos-related disease at cumulative doses of less than 50 fibre years per ml. Restricting consideration to the men first employed after 1950 in whom measurements of dose and response were more accurate does not alter these conclusions significantly. Of two studies from North America, one suggests that impairment of lung function may be detectable at cumulative doses at the lower end of the range (between 10 and 200 million particle years per cubic foot) while the second suggests a threshold of 200 fibre years per ml below which no impairment of lung function takes place. The only study of mortality from asbestosis which can be related to dose shows an increase of mortality with dose.

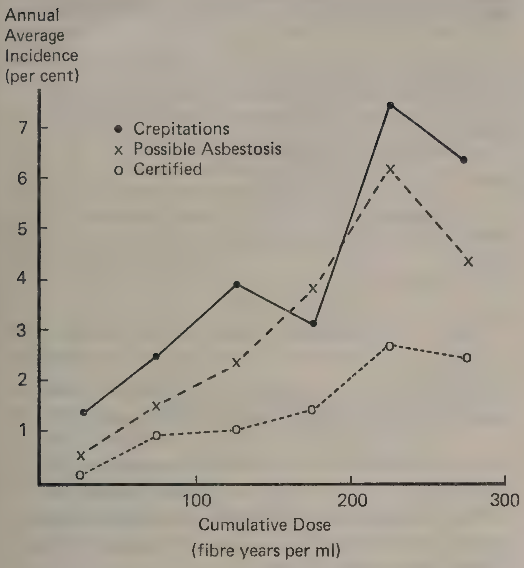


Fig 4 (see Vol 2 Fig 7) Average annual incidence rates (%) of 'asbestosis' defined in various ways according to cumulative dust exposure.
Note: The response of the three parameters are adequately described in statistical terms by straight lines.

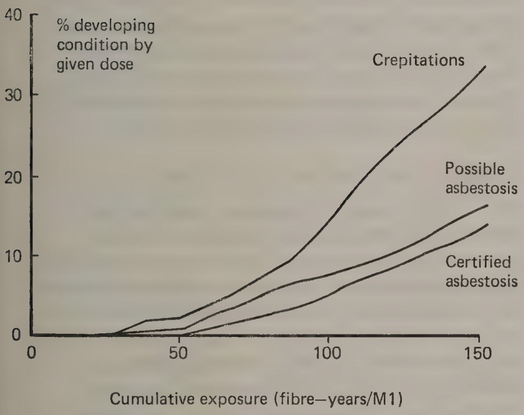


Fig 5 (see Vol 2 Fig 19) The relationship between the percentage developing crepitations, possible asbestosis and certified asbestosis, and cumulative exposure to asbestos, for men first employed after 1950. Taken from Berry, G (1977)[25].

94 Any application of the data discussed above to present or future working conditions depends upon the relationship of the measurements of dose made in the past to those on which the current and future standards are enforced, and upon the reliability of the clinical and other parameters of asbestosis. If the data are taken at their face value they indicate the occurrence of serious asbestos-related lung disease at an annual incidence rate of at least 0.5% per annum after a lifetime of work within the present hygiene standard. On the other hand if it is accepted that the doses inhaled by these men in the 1950s and 1960s have been underestimated by a factor of three or more, as compared with current methods, the hygiene standard as currently enforced would have been adequate to control serious disease (Fig 5). The interpretation of this important part of the evidence therefore depends largely on the view taken of the dust measurements used in these studies and upon the accuracy of the diagnosis of certified asbestosis at Rochdale. There is also uncertainty about how far it is reasonable to derive from data about asbestos textile workers conclusions extending to all situations where occupational exposure to asbestos occurs.

95 Additional studies are being undertaken by the British Occupational Hygiene Society. So far as the committee can tell on the basis of preliminary reports (Jan 1979) these studies are unlikely to alter previous findings substantially.

LUNG CANCER

96 For lung cancer the available data in man, all of which are derived from industry, show an increase in risk with increasing dose of dust, and we find no evidence within the range of dust levels studied for a threshold of dose below which there is no evidence of risk. For the Quebec chrysotile miners and millers and for the retired New Jersey asbestos workers that have been studied formal statistical tests show that the data are described by straight lines (Figs 6 and 7).

97 In a study of amosite factory workers, the occurrence of lung cancer appeared to be sub-linear in relation to the duration of employment (ie the rate of increase of risk was steeper at the lower end of the range of lengths of exposure) (Fig 8). Interpretation of this particular study is difficult for a number of reasons including the fact that information was presented only for the duration of employment and not for dust concentrations, but it is known that the exposures were by modern standards very high. No information is available about the dose-response relationship in workers exposed exclusively or almost exclusively to crocidolite.

98 In a discussion of the relationship of the risk of lung cancer, asbestos and cigarette smoking it is concluded that the data taken together show that exposure to asbestos dust probably increases the risk of lung cancer in man irrespective of smoking but much more in the presence of smoking than in its absence. The two factors (tobacco and asbestos) act synergistically but

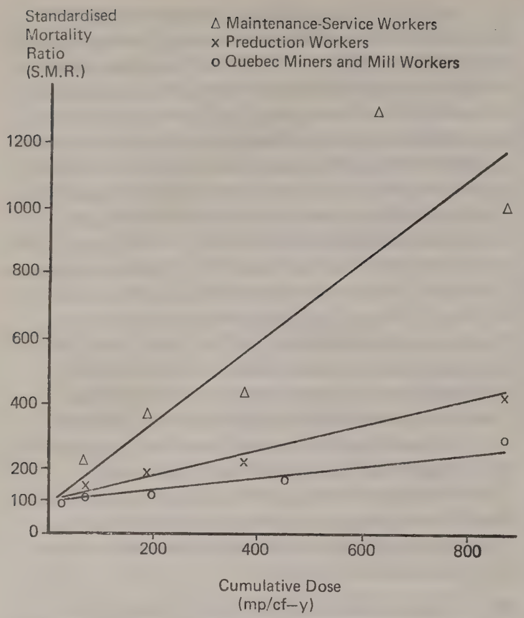


Fig 6 (see Vol 2 Fig 11) Dose-responses for lung cancer with freehand lines drawn.

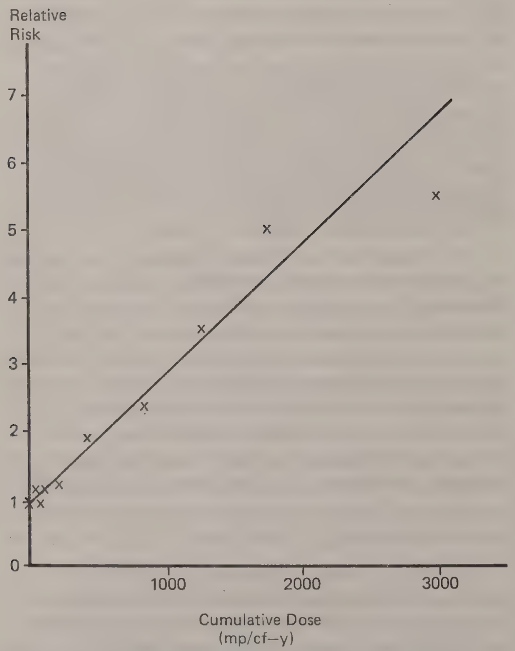


Fig 7 (see Vol 2 Fig 12) Lung cancer dose-response relationship for Quebec miners and millers.
Internal comparison: relative risks calculated relative to the low exposure group.[27]

Table 18 (see Vol 2 Table 31) Mesothelioma deaths in asbestos factory workers in Barking.

Type of exposure to asbestos	*Duration of employment*	*Deaths*	*Rate per 100 000 subject years**
Males			
Low to moderate	Under 2 years	3	31
	More than 2 years	5	83
Severe	Under 2 years	10	77
	More than 2 years	13	195
Total (males)		31	88
Females			
Low to moderate	Under 2 years	0	—
	More than 2 years	0	—
Severe	Under 2 years	9	106
	More than 2 years	5	126
Total (females)		14	97

*Can be regarded as 'rate per 100 000 per annum'
Source: Abstracted from Newhouse and Berry (1976)[26]

the exact relationship is uncertain and may be less than multiplicative. One consequence of this synergism is that any future diminution in the tobacco habit in persons exposed to asbestos will have a greater beneficial effect than in persons not so exposed.

MESOTHELIOMA

99 As far as mesothelioma is concerned the data so far available in man strongly suggest that the risk of this tumour increases with increasing dose. This is suggested by a study of 10 000 workers at a Barking factory by Newhouse and Berry[26] (Table 18); laggers were found to fare worse than process workers. The occurrence of cases due to domestic contact with people occupationally exposed and in the neighbourhood of factories and mines also suggests that relatively low doses may be followed by the development of cancer. However, information about the precise relationship between dose and response is lacking at present.

OTHER ASBESTOS RELATED DISEASE

100 As far as cancer of the gastro-intestinal tract is concerned, information about response to dose is limited to two studies reporting small excesses of these cancers, and the relationships are on the whole irregular and weak compared with lung cancer (Figs 9 and 10). It is worth noting, however, that a significant relationship between increasing dose and increasing response in statistical terms is present for cancer of the gastro-intestinal tract for maintenance workers (exposed to chrysotile and amphiboles) but not for factory workers engaged in the manufacture of asbestos textiles, building products and friction materials (exposed to chrysotile). Nothing definite can be said about the shape of the dose response curve or the existence or otherwise of a threshold.

101 For calcified pleural plaques an irregular increase in prevalence with increasing dose is observed in figures from the single study available (Fig 11) but in Quebec this phenomenon may be due to substances other than asbestos. No information is available on the dose-response relationship of cancer of the larynx.

Extrapolation and the public health

102 The view taken in this section depends upon firstly a number of the conclusions reached in the previous sections (recapitulated in summary form below); secondly certain assumptions about extrapolation of data derived from industry to situations where large numbers of persons are exposed to very low doses; thirdly, the evidence about the size of the population exposed and the severity and duration of the exposure outside the workplace.

103 The conclusions already reached relevant to this section are as follows:

(1) that asbestos fibres, principally comprising chrysotile and amosite, are continuing to accumulate in a wide variety of materials in the UK while, although raw crocidolite imports have ceased, a substantial amount of this material remains;

(2) that amphiboles and mixtures of chrysotile rich in amphiboles are certainly more dangerous than chrysotile alone in respect of mesothelioma and perhaps more dangerous in respect of lung cancer;

(3) that where quantitative data from industrial experience are available there is generally evidence for the existence of an increasing biological response to increasing dose; within the industry we have found no convincing evidence for the existence of a threshold below which no increment of risk takes place for lung cancer or mesothelioma and where sufficient data are available (as in the case of chrysotile and lung cancer, and mixtures of chrysotile and amphiboles and lung cancer) they are consistent with the linear hypothesis. For the other fibres in relation to lung cancer and for mesothelioma in relation to all three fibre types the precise shape of the dose-response curves is unknown. For gastro-intestinal cancer the question of the existence of a threshold is unsettled.

(4) The significance of minor clinical and radiological changes is in so much doubt that extrapolation from industrial experience in respect of asbestosis to the general

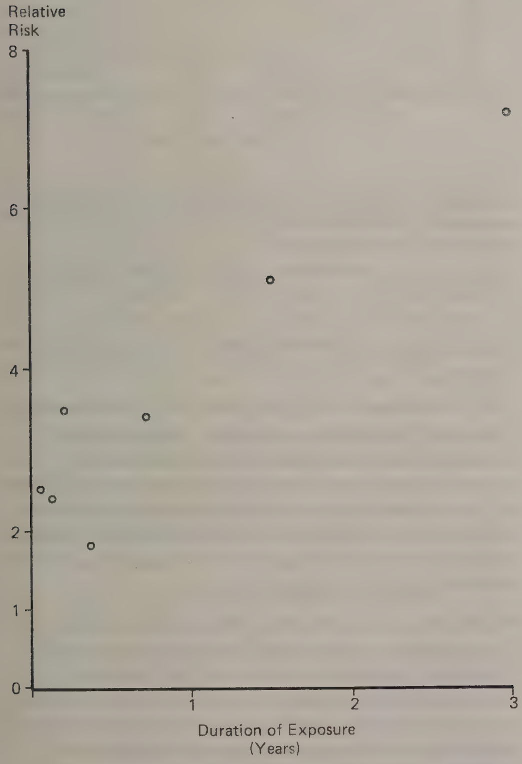


Fig 8 (see Vol 2 Fig 13) Relative risk of death from lung cancer in a group of amosite insulation workers by duration of exposure (After Seidman et al.)[21]

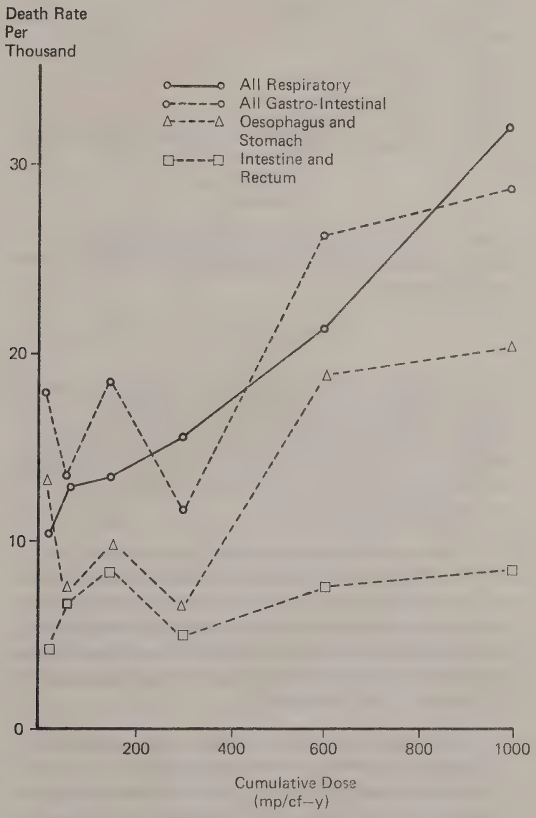


Fig 9 (Vol 2 Fig 15) Mortality from GI cancer and dust in Quebec miners and millers.
Source: McDonald JC and McDonald AD (1977).[29]

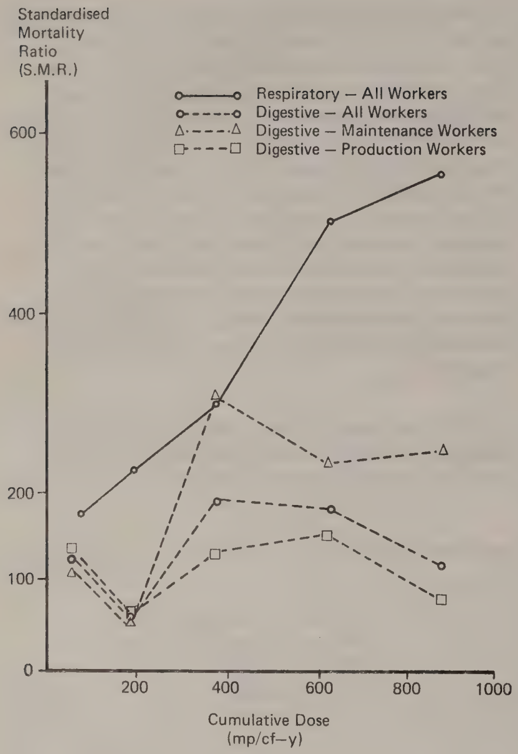


Fig 10 (Vol 2 Fig 16) Mortality from GI cancer and dust in retired production and maintenance workers.
Source: Enterline 1972.[5]

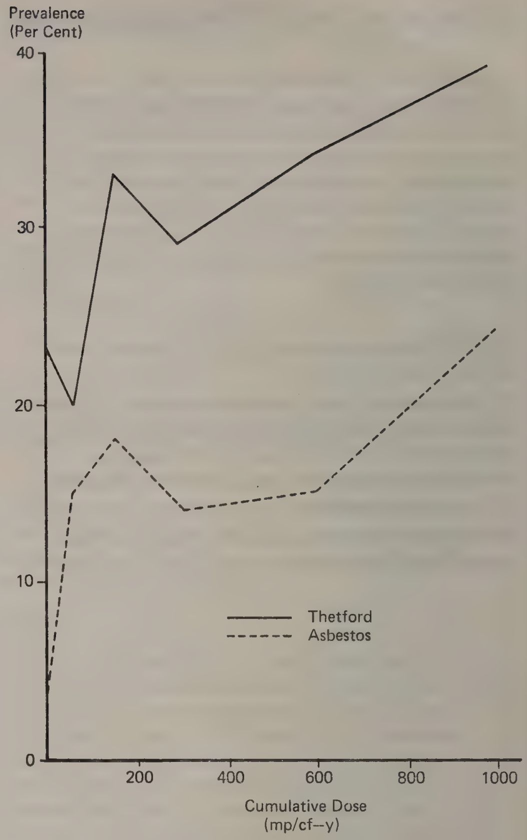


Fig 11 (see Vol 2 Fig 8b) The prevalence in Quebec chrysotile miners and millers in the Thetford and Asbestos areas of pleural changes, by cumulative dose of dust.

Source: Becklake, MR (1976)[29] and McDonald JC & Becklake MR (1975)[30]

population is not possible. But despite the high proportion of individuals, especially in urban areas, with asbestos fibres in their lungs, there has been no general reporting of asbestosis in the general public. This suggests that there may be a threshold level here below which asbestosis is not detectable.

104 In extrapolating from industrial data to the generally lower doses of the non-industrial situation we prefer the linear hypothesis for asbestos-related lung cancer, although it is important to emphasise that there is considerable uncertainty about the form of the relationship, and forms other than a linear relationship cannot be excluded at very low doses.

105 Our reasons for preferring a linear hypothesis are:
 it fits the data for occupational exposures;
 it is the simplest hypothesis and the one most readily used for extrapolation to the probable effects of low doses;
 it is likely to lead to an overestimate rather than an underestimate of risks at very low doses.

CONTAMINATION OF THE AIR, WATER AND FOOD

106 Measurements of small quantities of asbestos in air, water and food are at an early stage, subject to large errors and rarely recorded by a method or in units comparable to the industrial data on which our knowledge of the response of the human body to dose of asbestos currently depends, as the Food Additives and Contaminants Committee (FACC) have acknowledged. The uncertainties are therefore very great.

With the exception of a study of contamination near dumps of waste containing asbestos, no measurement in air out of doors has shown values within several orders of magnitude of the present standard for chrysotile. In a study of air collected within buildings containing asbestos (see Chapter 2) the peak figure identified was 0.08 fibres/ml (this figure is 4% of the current standard for chrysotile and 40% of the standard for crocidolite based on 8 hour exposure) (Table 19). However most of the buildings (82%) had very low readings, ie less than

Table 19 (see Vol 2 Table 33) Asbestos dust concentrations in UK buildings according to (a) materials used, (b) type of building (Byrom and colleagues, 1969).[32]

	Type of material				*Total*	
Fibres per cm³	*Insulation board*	*Asbestos cement sheeting*	*Sprayed asbestos*	*Other**	*No.*	*%*
0—0.005	17	2	7	8	34	46
>0.005—0.01	8	3	5	0	16	22
>0.01—0.02	6	2	2	0	10	14
>0.02—0.03	2	1	3	0	6	8
>0.03—0.04	2	0	0	0	2	3
>0.04—0.05	2	0	0	0	2	3
>0.05—0.08	2	0	1	0	3	4

*compressed flat sheets, partition board and low density panels.

									Total	
Fibres per cm³	*Hospital*	*Education*	*Factory or storage*	*Office*	*Shop*	*Place of assembly*	*Residence*	*Misc.*	*No.*	*%*
0—0.005	4	15	3	6	1	2	3	0	34	46
>0.005—0.01	1	3	2	2	4	2	1	1	16	22
>0.01—0.02	1	0	4	0	1	1	2	1	10	14
>0.02—0.03	2	0	2	0	0	0	2	0	6	8
>0.03—0.04	0	1	0	1	0	0	0	0	2	3
>0.04—0.05	0	0	0	1	0	0	1	0	2	3
>0.05—0.08	0	0	0	2	0	0	0	1	3	4

1 % of the present standard for chrysotile. We conclude that, in view of the presence in certain buildings of asbestos products, some of which contain crocidolite or amosite which may be subject to abrasion or damage during normal use, larger samples of buildings should be studied, particularly where amphiboles have been sprayed or used in insulation board.

107 Studies of lung tissue taken in samples of persons subjected to autopsy have shown that the prevalence of embedded asbestos fibre may be as high as 50 %, that the prevalence is increasing and that it varies geographically. The component of this prevalence which is occupational, or non-occupational in origin, is not clear from the published work. Many of the fibres found are extremely short.

108 There is no published information about the presence or otherwise of asbestos fibres in water in the UK. There is evidence from abroad which suggests that fibres may be leached from asbestos-containing pressure piping under certain circumstances. Fibres from asbestos deposits in other rocks and ores and from industrial contamination of water supplies have also been found. Following on from the report of the FACC and the results of investigations by the DOE, we believe that it would be advisable to study this phenomenon within the range encountered for the UK of acidity and other chemical characteristics of water supplies for households and the manufacture of food and drink.

The public health risk

AIR

109 We conclude that the presence of chrysotile containing small quantities of amphiboles is unlikely to have produced any material increase in the risk of lung cancer in the general population or any appreciable number of cases of mesothelioma. The same is certainly true of asbestosis. Pleural changes similar to those associated with occupational exposure occur in circumstances where occupationally related exposure is unlikely. The relationship of these to environmental asbestos or other minerals is not proven. Cases of pleural thickening and calcification have been reported in those presumed to have been exposed to asbestos dust non-occupationally in the neighbourhood of mines and factories.

110 As far as the amphiboles crocidolite and amosite and mixtures rich in them are concerned, the position is less certain because of the lack of quantitative data about the relationship of response to dose. Such data as exist suggest that the risk of lung cancer associated with amphiboles may be greater than for chrysotile. An excess lung cancer risk cannot be completely excluded, at

Table 20 A comparison of the number of deaths from cancer and mesothelioma in the UK during 1975

all cancers	139,899	UK
lung cancer	37,152	
mesothelioma	256	

Source: Annual Abstract of Statistics 1976. Mesothelioma Register

present, in those who have been exposed only to amphiboles in buildings. But the number of cases, if any, is probably very small.

111 While the majority of reported mesotheliomas are attributable to occupational and indirect occupational exposure to amphiboles, some cases have been reported where the exposure has arisen as a result of domestic contact or neighbourhood exposure. Other mesotheliomas cannot be convincingly attributed to asbestos exposure but some of these in other countries appearto have been caused by other fibrous minerals. A marked feature of the asbestos-related mesotheliomas has been the geographical clustering of cases in areas where large quantities of amphiboles were handled. The absolute number of mesotheliomas registered in comparison with other causes of death is low (see Table 20), but despite the improvement of industrial practice in the last twenty years and a number of other favourable points which have been mentioned above which give grounds for optimism, an important area of uncertainty remains.

THE RISK TO CHILDREN

112 Although published instances of asbestos related disease due to the exposure to asbestos of children at home, in schools and in the vicinity of dumps attract attention, they are rare. However, further surveys of school buildings containing asbestos and of dumps in the vicinity of asbestos factories on which children might play are desirable for two reasons. The first is that susceptibility to cancer is known to vary with age, the very young being especially at risk in relation to certain stimuli. The second is that as children can be expected to live longer than adults they have more chance of being affected by carcinogens with long latent periods.

WATER, FOOD AND BEVERAGES

113 The scale of consumption of drinking water supplied through asbestos-containing pipes is such that even a very small increase in risk of abdominal tumours, should it be found to exist, might cause an appreciable number of cases in absolute terms. It would also be extremely difficult to detect. There is however no evidence of the existence of risk in animals associated with the ingestion of asbestos. Industrial experience suggests that any risk in man may be limited to persons exposed to high doses, and the quantities of asbestos fibres in water have been found in other countries to be extremely low. It is understood, however, that further studies on the ingestion of asbestos are being carried out. Following on from the FACC report, we believe that studies of the leaching of asbestos fibres from pressure pipes in the range of acidity encountered in UK public water supplies should be undertaken.

Types of asbestos: implications for public policy

114 Following the lines laid down in the terms of reference of the report each type of asbestos fibre is dealt with separately in this section. However it is important to repeat here a point made in earlier sections. This is that the conclusions reached about the effects of the different fibre types on man relate to past industrial practices, and that any change in industrial practice in the direction of the production of more finely divided fibre is likely to increase the health risk.

CROCIDOLITE

115 There is strong evidence from a number of sources that inhalation of crocidolite can cause mesothelioma, and that although the risk increases with increasing dose it is possible for mesothelioma to occur after relatively brief exposure to this amphibole. A substantial proportion of the deaths from mesothelioma which have occurred and are occurring in Britain have probably been due to the inhalation of amphiboles including crocidolite. Although the available evidence is inconclusive it is consistent with the view that crocidolite may also have been more dangerous than chrysotile as far as the causation of lung cancer is concerned. Crocidolite is one of the amphiboles associated with the excesses of cancers of the gastro-intestinal tract (if these are in reality not misdiagnosed peritoneal mesotheliomas) and may also be concerned in a small number of cases of laryngeal cancer. Evidence from the only study in man in which quantitative comparisons between crocidolite and chrysotile are possible suggests that crocidolite may cause more asbestosis than chrysotile. The animal work on this point is conflicting.

116 We believe that contact between man and crocidolite should be limited to the minimum practicable and stringent regulations for the protection of workers and of the public should continue to be applied in respect of crocidolite-containing materials still present in buildings, vehicles, ships, dumps and other locations.

AMOSITE

117 The importance of reaching a correct judgment about the amphibole amosite is underlined by the import trends to the UK since World War II which show a sevenfold increase in tonnage imported compared to a twofold increase in chrysotile. The tonnage of amosite imported in 1975 (19 200 tonnes) was almost three times the largest import figure for crocidolite since 1945 (6800 tonnes); (see Table 3 of Chapter 1).

118 The principal difficulty about the evidence on the effects of amosite upon health is that very few definable groups of men have been exposed to amosite who have not also been exposed to crocidolite, particularly in the United Kingdom. As a cause of mesothelioma, we take the view that the risk from amosite may be intermediate between chrysotile and crocidolite. For reasons argued

in detail in Volume 2, we consider that the majority of the cases of mesothelioma reported in insulators in North America have probably been associated with exposure to mixtures of chrysotile and amosite, not crocidolite. Eleven mesotheliomas have been reported among workers in a factory making marine insulation material from amosite. There are also four well attested cases of mesothelioma in domestic contacts of amosite workers. We are inclined to ascribe the lack of an appreciable number of mesotheliomas reported amongst amosite mine workers in South Africa to the low concentrations of respirable fibres at the mines in the past and to the lack of follow-up of the workers.*

119 The evidence about the capacity of amosite alone to produce lung cancer depends at present upon the experience of the men at a single American factory manufacturing insulation materials. This study shows excess risks of lung cancer even after very short exposures (Table 16) and although measurements of dust levels are not available the most likely interpretation is that the risk was higher than for men exposed to similar doses of chrysotile. Mixtures of amosite with chrysotile in American insulators are associated with very high relative risks of lung cancer, but once again unfortunately dust levels are not available.

120 Excesses of gastro-intestinal cancers (which may have been misdiagnosed mesotheliomas) have occurred in heavily exposed amosite workers and in American insulation workers for whom we believe the principal amphibole inhaled has been amosite.

121 For asbestosis there is no quantitative evidence in man which compares the fibrogenicity of amosite with other types of asbestos, while in animals the evidence about its relative fibrogenicity is conflicting.

122 We conclude that, although strictly quantitative data are lacking, the burden of the evidence suggests strongly that amosite has been more dangerous than chrysotile in respect of mesothelioma and possibly also in respect of lung cancer. If this conclusion is accepted the question must arise whether a more stringent hygiene standard should be applied to amosite than to chrysotile.

TREMOLITE

123 Although the amphibole tremolite is not used commercially it is known to contaminate certain samples of commercial asbestos and to be present either in 'platy' or fibrous form in industrial talcs. Studies by HSE have indicated that in the UK the contamination of commercial talcs by fibrous tremolite is negligible, however a firm conclusion on this cannot be drawn at present as the identification and analysis of talc samples is difficult and further research is needed to establish a suitable method for the compositional analysis of talc.

124 Electron microscopic studies have identified tremolite fibres in the lungs of deceased chrysotile miners some of whom had asbestosis and some of whom had not. The question has been raised whether tremolite may have biological significance and animal experimental evidence is being sought to determine whether tremolite is fibrogenic and/or carcinogenic. Studies are also needed to assess the possible health risk from tremolite and other asbestiform contaminants present in talc taking into account the occurrence and use of the contaminant.

125 Although no human population has been identified which has been exposed industrially to tremolite alone, a group of 250 American talc miners who were exposed to tremolite and serpentine have been followed over a period of 25 years. One death from peritoneal mesothelioma, one from pleural fibrosarcoma and an excess of lung cancer deaths were recorded.

CHRYSOTILE

126 Chrysotile is the only type of asbestos fibre for which data are available that permit some quantitative estimates to be made of the biological effect of a given dose of fibre. Nevertheless, for reasons already given, very considerable errors in estimation, both of the dose and of the biological effect, may exist and we are dealing with the best estimates available.

127 The present hygiene standard of 2 fibres/ml was arrived at in 1968 on the basis of a study of asbestos textile workers in employment in 1966 at Rochdale. It was estimated that exposure to an average of 2 fibres per ml 8 hours a day 5 days a week for 50 years would lead to the occurrence of an early but non-specific sign of asbestosis (crepitations) in 1% of the workers at the end of their working lives. A second study[24] taking account of the men who had left shows that the rate of occurrence of crepitations at the current hygiene standard over 50 years had been under-estimated by a factor of about 15. Even if the significance of crepitations as an isolated sign is discounted the second study shows that an annual incidence of certified asbestosis of 0.5% (Standard Error 0.2%) would occur after an exposure within the present standard. However, if one is able to accept, as has been suggested on the basis of parallel measurements, that modern personal sampling techniques such as are used to enforce the standards at present would have arrived at measurements of dust at Rochdale in the 1950's and 1960's 2 to 5 times those used in the calculations, the evidence in favour of certified asbestosis occurring at Rochdale after a lifetime's work at the present standard is correspondingly reduced. The implications of the data from these two studies on public policy with regard to the hygiene standard depend to a large extent therefore on the view taken about the relationship of the dust measurements in them to current measurements.

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* Five cases of mesothelioma have been reported following exposure to amosite at Penge, Transvaal. Two whites and one black worked in the mine. One case occurred in a person who lived at Penge and another in a person who visited Penge as a child. There was no known exposure to crocidolite or chrysotile in any of these cases. (Webster I, National Centre for Occupational Health, Johannesburg, personal communication).

128 In respect of carcinogenicity we conclude that up to the present time chrysotile has rarely caused mesothelioma or cancer of the larynx. These are favourable points which should be taken into account in framing policy. On the other hand it is essential to restate the proven capacity of chrysotile to produce mesotheliomas in animals if the fibre is of the appropriate configuration, and to emphasise once again that chrysotile is probably becoming increasingly finely divided and respirable.

129 In the case of lung cancer there are two studies from North American and one from Britain which provide data which can be used to help us arrive at a standard. In the North American studies (Quebec miners and Enterline's process workers) the doses of dust are recorded in particles per cubic foot. It follows that if use is to be made of them a transformation must be carried out. This at best introduces additional uncertainties. Our approach has been to show the effect of three possible conversion factors. For the Rochdale lung cancer study we show the effect of taking the dust levels as measured and of increasing them by factors of 2 and 5 to take account respectively of the effect of modern instruments, and of the combined effect of modern instruments and personal samplers (see Table 17).

130 The array of figures in Table 21 sets out the excess mortality from lung cancer which would occur to workmen exposed to various chrysotile levels over 50 years from calculations based on the various studies. A range of excesses is allowed for from 2% (i.e. that 2% more of the men exposed at the given level would die of lung

Table 21 (see Vol 2 Table 35) Dust concentrations in fibres/cc that would produce shown excess mortality from lung cancer after 50 years exposure according to linear dose-response models.

			Dust levels for stated excess mortality from lung cancer			
Study	*Fibre type**	*Conversion factor†*	0.1%	0.5%	1%	2%
Quebec	C	5	0.5	3	5	11
		2	0.2	1	2	4
		1	0.1	0.5	1	2
Enterline (production workers)	C	5	0.3	1	3	5
		2	0.1	0.5	1	2
		1	0.1	0.3	0.5	1
Enterline (maintenance workers)	C, A, Cr	5	0.1	0.4	0.8	2
		2	0.04	0.2	0.3	0.6
		1	0.02	0.1	0.2	0.3
Rochdale	C, ? Cr	—	0.04	0.2	0.4	0.8
		2	0.08	0.4	0.8	1.6
		5	0.2	1	2	4

*C = Chrysotile, A = Amosite, Cr = Crocidolite.

†For Quebec[27] and Enterline[5] studies figures are ratios of fibres per cc to million particles per cubic foot.

For Rochdale conversion factors are the lowest and highest shown in Table 17 to convert to modern techniques with personal sampling.

Table 22 (see Vol 2 Table 36) Number of excess deaths from lung cancer among one million people that might be caused by the highest observed environmental asbestos dust levels in ambient air and the median or highest levels encountered by Byrom in buildings if they were exposed continuously for 50 years.

			Number of extra deaths from lung cancer among 10^6 births from stated exposure to asbestos in fibre years per cc		
Study	*Fibre type†*	*Conversion factor†*	**0.01***	**0.25††**	**4****
Quebec	C	5	0.2	5	81
		2	0.5	12.5	203
		1	1.0	25	405
Enterline (production workers)	C	5	0.4	10	162
		2	1.0	25	405
		1	2.0	50	810
Enterline (maintenance workers)	C, A, Cr	5	1.4	35	540
		2	3.4	85	1 350
		1	6.8	170	2 700
Rochdale	C, ? Cr	–	2.7	68	1 080
		2	1.4	34	540
		5	0.5	14	216

† See Table 21.

* 10 nanograms per cubic metre for 50 years taken to be equivalent to 0.01 fibre years per cc.

**0.08 fibres per cc for 50 years is equivalent to 4 fibre years per cc.

†† 0.005 fibres per cc for 50 years is equivalent to 0.25 fibre years per cc.

cancer than if they had not been exposed, and would die at an earlier age) to 0.1 %. As in this table the assumption of a linear relationship between dose and response is made, any other value can be found by simple proportion. The details of the various other assumptions on which the table is based are given in volume 2.

131 If we take as an example the column of Table 21 showing the levels at which a 1 % excess of lung cancer deaths would occur associated with chrysotile, we find a range of figures from 5 fibres per ml to 0.4 fibres per ml (for 50 years). In other words, taking the various different sets of data and using different assumptions we calculate that any value from 5 fibres per ml to 0.4 fibres per ml might lead to a yield of 1 % excess deaths from lung cancer. The calculated levels are correspondingly lower for an excess yield half as great (i.e. 0.5 %).

132 The possible risk to the general public also has to be taken into account in making a decision about a hygiene standard. In Table 22, using the same studies as in Table 21, we have calculated the excess number of lung cancer deaths which would occur if a million persons were exposed continuously 8 hours a day 5 days a week for 50 years to the highest recorded concentration of asbestos in the ambient air out of doors (10 nanograms per m^3) or to the median, or highest levels recorded by Byrom and others in their survey of buildings (Table 19). It can be seen that unless contaminated buildings are very much commoner than seems likely no appreciable mortality from lung cancer can be associated with any degree of contamination by chrysotile likely to be encountered in the UK in the ambient air or in buildings not under active construction or repair. However we emphasise once more the need for further information about asbestos levels in buildings.

133 The effect of occupational exposure to asbestos on the mortality from lung cancer is therefore the main evidence on which to base a final conclusion about a hygiene standard for chrysotile. In choosing a figure it should be borne in mind that there are number of identifiable factors in the various estimates which exert opposite effects. The linear hypothesis may over-estimate the risk but the Quebec data (because they are derived from mines and mills) and Enterline's data (because they are restricted to men who survived long enough to reach pensionable age) may under-estimate the average risk to men exposed for the whole of a working life to more finely divided fibre in process work. An assumption implicit in the use of cumulative dose is that the increase in cancer risk of added asbestos dust operates immediately. The assumption also carries with it the implication that the time the fibre remains in the lung is unimportant and that no allowance is made for continuing action of the fibres in the body or of the reduction of risk with their elimination. In practice it is known that there is a long interval between first exposure and the onset of the excess cancer risk. Calculation of the dose of dust, from past exposure is difficult, and for Rochdale it has been suggested that past dust levels may have been under-estimated.

134 A comparison with the health standard for ionising radiations (5 rems per annum) may be helpful. The standard is such that there is likely to be an increase in

Table 23 (see Vol 2 Table 22) Occurrence and approximate average annual incidence of newly diagnosed disease related to dust exposure in men in Rochdale from 1966 to last follow-up by time of first employment. Based on Berry, G (1977)[25]. Average length of follow-up taken to be 6.5 years

		Crepitations			*Possible asbestosis*			*Certified asbestosis*			*Possible and/or certified asbestosis*			*Any new disease*		
Cumulative dose	*Number of men*	*Cases*	*%*	*Annual %*	*Cases*	*%*	*Annual %*	*Cases*	*%*	*Annual %*	*Cases*	*%*	*Annual %*	*Cases*	*%*	*Annual %*
(a) Men first employed before 1951																
<50	5	1	20	3.1	1	20	3.1	0	0	0.0	1	20	3.1	1	20	3.1
50 –	25	5	20	3.1	3	12	1.8	1	4	0.6	3	12	1.8	5	20	3.1
100 –	36	11	31	4.7	6	17	2.6	3	8	1.3	6	17	2.6	11	31	4.7
150 –	44	11	25	3.8	10	23	3.5	5	11	1.7	11	25	3.8	16	36	5.6
200 –	39	8	21	3.2	8	21	3.2	4	10	1.6	9	23	3.6	10	26	3.9
250+	33	12	36	5.6	12	36	5.6	9	27	4.2	13	39	6.1	15	45	7.0
Total	182	48	26	4.1	40	22	3.4	22	12	1.9	43	24	3.6	58	32	4.9
(b) Men first employed after 1951																
<50	36	3	8	1.3	1	3	0.4	0	0	0.0	1	3	0.4	4	11	1.7
50 –	95	11	12	1.8	6	6	1.0	6	6	1.0	7	7	1.1	12	13	1.9
100 –	52	11	21	3.3	3	6	0.9	5	10	1.5	5	10	1.5	13	25	3.8
150+	14	1	7	1.1	2	14	2.2	1	7	1.1	2	14	2.2	1	7	1.1
Total	197	26	13	2.0	12	6	0.9	12	6	0.9	15	8	1.2	30	15	2.3
(c) All men in study																
<50	41	4	10	1.5	2	5	0.8	0	0	0.0	2	5	0.8	5	12	1.9
50 –	120	16	13	2.1	9	8	1.2	7	6	0.9	10	8	1.3	17	14	2.2
<100	161	20	12	1.9	11	7	1.1	7	4	0.7	12	7	1.1	22	14	2.1
100 –	88	22	25	3.8	9	10	1.6	8	9	1.4	11	13	1.9	24	27	4.2
150 –	58	12	21	3.2	12	21	3.2	6	10	1.6	13	22	3.4	17	29	4.5
200 –	39	8	21	3.2	8	21	3.2	4	10	1.6	9	23	3.6	10	26	3.9
250+	33	12	36	5.6	12	36	5.6	9	27	4.2	13	39	6.1	15	45	7.0
Total	379	74	20	3.0	52	14	2.1	34	9	1.4	58	15	2.4	88	23	3.6

cancer mortality from 20% (which is the probability of a member of the general population dying from cancer from all causes) to 22% of all deaths if workers are exposed to this level annually for 50 years. However the great majority of workers are only exposed to much lower levels and it is estimated that the overall excess mortality from cancer is thus reduced to an average of 0.2%. If this is regarded as an acceptable parallel to the situation with regard to chrysotile, it will be of interest to calculate the level of chyrostile dust exposure associated with a 0.2% overall excess mortality from asbestos-related diseases. If we assume that the exposure pattern for asbestos workers is roughly the same as for workers exposed to ionising radiation (that is, that the average exposure will in practice be about one-tenth of the limit set), then we should look for the exposure level associated with a 2% excess mortality among the most highly exposed. Since, very approximately half the mortality attributable to chrysotile is due to lung cancer and half to asbestosis, this suggests that we should look in the column headed 1% in Table 21, which deals with lung cancer only. The chrysotile levels in this column range from 5 fibres/ml to 0.4 fibres/ml. Bearing in mind the points made in the previous paragraphs a figure towards the lower end of this range might represent a compromise between what are, indeed, very considerable uncertainties.

135 In addition to the excess mortality there is also the morbidity from asbestosis to be taken into account. The difficulties of assessing this due to the variation in clinical effects and diagnosis have already been mentioned, but with this proviso, an estimate can be obtained for a given dose in fibre/ years/ml from Table 23.

1 Timbrell V (1973) Physical factors as aetiological mechanisms. In Bogovski P, Gilson JC, Timbrell V and Wagner JC. Biological effects of Asbestos (IARC Scientific Publications, No 8), pp 295–303.

2 Selikoff IJ (1976) Ann NY Acad Sci, *271*, 448. Lung cancer and mesothelioma during prospective surveillance of 1249 asbestos insulation workers, 1963–74.

3 Elmes PC and Simpson MJC (1971) Brit J Industr Med, *28*, 226. Insulation workers in Belfast. 3. Mortality 1940–66.

4 Selikoff IJ and Hammond EC (1975) Multiple risk factors in environmental cancer. In: Persons at high risk of cancer: An approach to cancer aetiology and control, ed Fraumeni JF, Academic Press, London, p 467.

5 Enterline P, De Coufle P and Henderson V (1972) J Occup Med, *14*, 897. Mortality in relation to occupational exposure in the asbestos industry.

6 Newhouse M (1973) Cancer among workers in the asbestos textile industry; In Bogovski P et al (eds), p 203.

7 Mancuso TF and El-Attar AA (1967) J Occup Med, *9*, 147. Mortality pattern in a cohort of asbestos workers.

8 McDonald JC, Liddell FDK, Gibbs GW and McDonald AD (1977) Dust exposure and mortality in chrysotile mining 1910–75. Unpublished data.

9 Peto J, Doll R, Howard S, Kinlen LJ and Lewinsohn HC (1977) Brit J Industr Med .A mortality study among workers in an English asbestos factory. (1977) Brit J Ind Med, *34*, 169–173.

10 Selikoff IJ, Hammond EC and Seidman H (1973): In Bogovski P et al (eds), p 203.

11 Stell PM and McGill T (1973) Lancet, *2*, 416. Asbestos and laryngeal cancer.

12 Shettigara PT and Morgan RW (1975) Arch Environm Hlth, *30*, 517. Asbestos, smoking and laryngeal cancer.

13 Newhouse ML and Berry G (1973) Lancet, *2*, 615. Asbestos and laryngeal carcinoma.

14 Selikoff IJ (1976) Paper presented at the Meeting on Origins of Human Cancer, at Cold Spring Harbour Laboratory, New York. *Cancer risk of asbestos exposure.*

15 Enterline P, De Coufle P and Henderson V (1973) Brit J Industr Med, *30*, 162. Respiratory cancer in relation to occupational exposures among retired asbestos workers.

16 Peto J (1977) Unpublished data from Rochdale. Personal communication to the authors.

17 Newhouse ML (1977) Personal communication.

18 Meurman LO, Kiviluoto R and Hakama M (1974) Brit J Industr Med, *31*, 105. Mortality and morbidity among the working population of anthophyllite asbestos miners in Finland.

19 Wagoner JK, Johnson WM and Lemen R (1973) Congressional Record of the US Senate, March 14, S4660. Malignant and non-malignant respiratory disease mortality patterns among asbestos production workers.

20 Enterline P and Henderson V (1973) Arch Environ Health, *27*, 312. Type of asbestos and respiratory cancer in the asbestos industry.

21 Seidman H, Lilis R and Selikoff IJ (1977) Short-term asbestos exposure and delayed cancer risk. In Proceedings of Third International Symposium on the Detection and Prevention of Cancer, New York, Part I, Vol I, Chapter 10. In press.

22 Holmes S (1978) Evidence submitted to the Health and Safety Executive.

23 Steel J (1978) Appendix B of final report of Advisory Committee on Asbestos.

24 Berry G, Gilson JC, Holmes S, Lewisohn and Roach SA *Asbestosis: A Study of dose-response relationships in an asbestos textile factory.*

25 Berry G (1977) Paper submitted as evidence to the Advisory Committee on Asbestos: *Health and dust exposure in a group of asbestos workers.*

26 Newhouse ML and Berry G (1976) Brit J Industr Med, *33*, 147. Predictions of mortality from mesothelial tumours in asbestos factory workers.

27 Liddell FDK, McDonald JC and Thomas DC (1977) J Roy Stat Soc A, *140*, 469. Methods of cohort analysis: appraisal by application to asbestos mining.

28 McDonald JC (1973) Cancer in chrysotile mines and mills: In Bogovski, Petal (eds) p 189.

29 Becklake MR (1976) Amer Rev Resp Dis, *114*, 187. Asbestos related diseases of the lung and other organs: their epidemiology and implications for clinical practice.

30 McDonald JC and Becklake MR (1975) Paper presented at Zweiten Deutsch-Osterreichisch-Schweizerischen Untalltagung, Berlin. Asbestos related disease in Canada.

31 Byrom JC, Hodgson AA and Holmes S *A dust survey carried out in buildings incorporating asbestos-based materials in their construction* Annals of occupational hygiene 1969 *12*, 141–45.

Appendix K

Explanation of some of the terms used in Chapter 3

K1 Chapter 3 does not pre-suppose any knowledge of epidemiology or statistics, but it was found impossible to avoid technical terms entirely. Readers may find the following explanations useful.

CUMULATIVE DOSE—FIBRE YEARS PER MILLILITRE AND PARTICLE YEARS PER CUBIC FOOT

K2 One hundred fibre years per ml is the cumulative dose that would result from, for example, exposure to a constant dust concentration of 10 fibres per ml over 10 years, or 2 fibres per ml over 50 years, for 8 hours a day and 5 days a week. Similarly 100 million particle years per cubic foot is the cumulative dose that would result from, for example, exposure to a constant dust concentration of 10 million particles per cubic foot over 10 years, or 2 million particles per cubic foot over 50 years, for 8 hours a day and 5 days a week. The abbreviation for million particle years per cubic foot used in the figures is mp/cf–y.

EXCESS MORTALITY

K3 If in a given group of people there is an excess mortality of 2% from cancer, this means that 2% more of these people die of cancer than would do so if their causes of death were exactly the same as those found in some reference group (usually the population as a whole), and these deaths occur earlier than they would otherwise. So, if for example 20% of the reference group die of cancer, the percentage dying of cancer in the group under study will be 22%.

PREVALENCE AND PREVALENCE RATES

K4 If the prevalence of asbestosis in a given factory is 5 on 1 January 1978, this means that 5 of the population in that factory had asbestosis on that date. This figure tells us little unless we know the size of the population. Prevalence is therefore usually expressed as a prevalence rate: for example, a 6% prevalence rate for asbestosis in a given factory on 1 January means that on average 6 in every 100 employed in the factory had asbestosis on that date.

INCIDENCE AND INCIDENCE RATES

K5 Incidence, unlike prevalence, measures only the new cases diagnosed or reported in a given period (usually a calendar year). But, again, an incidence figure without any indication of the population involved is not very useful. For this reason, it is again usual to express incidence as a rate. For example, if at a given factory there is an annual incidence rate of 2% for asbestosis during the period under review, this means that on average 2 people were diagnosed as new cases of asbestosis each year for every 100 employed.

AVERAGE ANNUAL INCIDENCE RATE

K6 This is the average over a period of years of the annual incidence rates for those years.

PERITONEUM

K7 A membrane, similar to the pleura, lining the abdomen.

New proposals on legal and administrative controls

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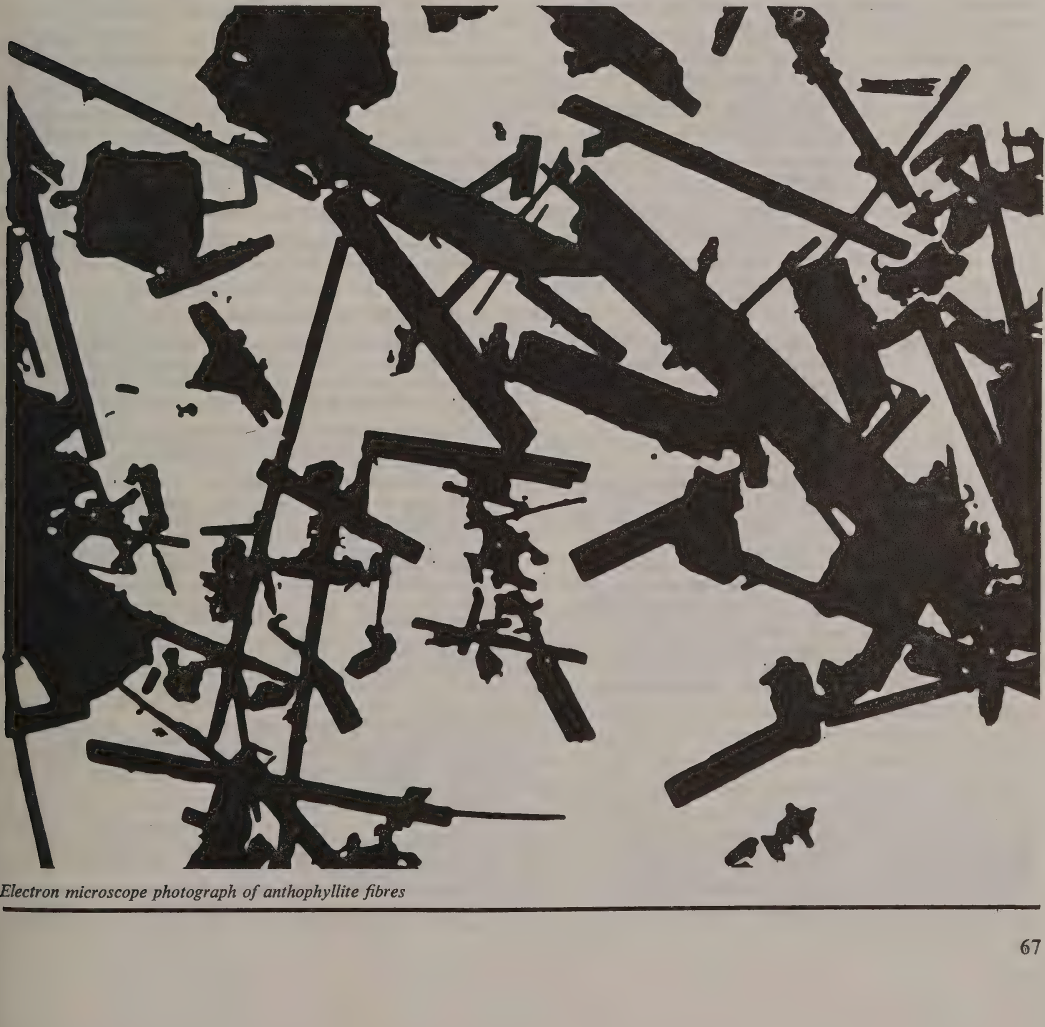

Electron microscope photograph of anthophyllite fibres

The workplace

136 In this chapter we consider changes we believe are needed in statutory provisions and administrative arrangements aimed at protecting workers exposed in the workplace. To allow a comparison between our recommendations and the existing controls, the latter are summarised in Table 24 and given in greater detail in Appendix L.

137 We are satisfied that the introduction of the Asbestos Regulations in 1969 and the hygiene standards which have been used in association with them have led to a significant reduction in the concentration of asbestos dust in factory atmospheres and thus to a reduction in the exposure of workpeople to asbestos. The actual reduction in numerical terms, however, is difficult to evaluate, as was clearly shown in the oral evidence put to us, because just before the regulations came into force the method of monitoring changed. Another significant effect of the regulations was the phasing out of the importation of raw crocidolite as a result of the stringent hygiene standard applied to this fibre.

138 For these and other reasons we take the view that the asbestos regulations provide an appropriate basis for the statutory control of the use of asbestos at work. Nevertheless there are some aspects of control which the existing regulations do not cover and to which we feel they should be extended.

139 The present regulations were made under the Factories Act 1961 but the powers under this Act were limited so that regulations could only apply to premises defined in the Act. Under the Health and Safety at Work etc Act 1974, powers are provided to make regulations which can extend to protect all people at work. We believe, therefore, that the scope of any amended version of the regulations ought to be extended to cover all persons affected by work activities.

Table 24 Current legal and administrative controls in the workplace

Relevant legislation etc	*General remarks*	*Summary of the relevant provisions*
Asbestos Regulations 1969	Asbestos is defined in the Regs. Places/Process to which Regs apply is stated. HSE Guidance Note gives hygiene standards as follows: 0.2 fibres/ml measured over 10 minute period } for crocidolite 2 fibres/ml averaged over 4 hours 12 fibres/ml averaged over 10 minutes } for other types of asbestos exposure to all types of asbestos dust should be reduced to the minimum that is reasonably practicable.	1 28 days written notice to HMFI before processes involving crocidolite begun. 2 Exhaust ventilation equipment to be provided, examined and maintained. 3 Where 2 is impracticable RPE* and protective clothing are required. 4 Workplaces to be kept clean and free from dust using dustless method (RPE required where this method impracticable.) 5 Dust and waste to be stored in suitable receptacles. 6 Changing/Storage facilities and cleaning to be provided for RPE and protective clothing. 7 Employment of persons under 18 prohibited in process, as using asbestos or for cleaning described in 6. 8 Certain requirements apply on cleanliness and cleaning systems in new buildings where Regs will apply. * RPE—Respiratory Protective Equipment.
Mines & Quarries Act 1954	S 74 applies to Mines and S 112 to Quarries. These sections primarily apply to risks from dusts other than asbestos but can be applied to any operation where asbestos dust is given off.	1 Mine managers have to see that dust of such a character or quantity as to be likely to be injurious to the persons employed is minimised and that any dust that enters the air is trapped or dispersed harmlessly. Any accumulation of dust should be cleared up, removed or treated to make it safe. 2 Quarry managers have a similar responsibility to 1 and a general duty to protect employees against the inhalation of dust.
Health & Safety at Work etc Act 1974	Although there is no special mention of asbestos or health risks from dusts in the Act, Sections 2, 3, 4 & 6 require employers, manufacturers etc to ensure the absence of risks to health so far as is reasonably practicable. This obliges an employer etc to do better than the standards if the necessary steps are reasonably practicable. The employer can choose the method for achieving the objective providing his obligation is fulfilled.	1 Employers etc. have a duty for the health* of: (1) their employees for the absence of risk to health in connection with use, handling, storage and transport of articles or substances. (2) persons other than their employees who: (a) may be exposed to risk from the employers work operations: or (b) may use premises owned by the employer etc. as a place of work. The owner has to see that the means of access or egress to the premises or any plant used there are without risks to health. 2 Manufacturers, designers, importers and suppliers of substances for use at work have to ensure* generally that these substances are and remain safe when put to their intended use. 3 Manufacturers etc should also inform purchasers about any conditions which have to be observed to ensure safety during use and carry out or sponsor research for discovery*, minimisation and elimination of any health risk the substance may give rise to. 4 There is also a duty for the best practicable means to prevent the emission into the atmosphere from prescribed premises of noxious or offensive substances and to render such substances as may be emitted as harmless and inoffensive. * As far as is reasonably practicable.
Social Security (Industrial Injuries) (Prescribed Diseases) Regs 1975	Reg 51 requires persons engaged in certain specified occupations involving risk of asbestosis to submit themselves for medical examinations.	1 Before employing a new worker an employer must arrange for the worker to be medically examined usually by informing his local Pneumoconiosis Medical Panel. 2 The first examination should be carried out within 2 months of the date the employee first starts and then further examinations every 2 years.

140 Hazards from manufacturing operations involving raw asbestos would clearly be abolished entirely if asbestos ceased to be used in manufacturing. We therefore consider first the question of statutory prohibition of asbestos use, and the related question of a statutory obligation to substitute other materials for asbestos or products containing it. But whether or not a general ban on asbestos in new products is justified, much asbestos will remain in the working environment for decades, as a component of products such as insulation materials, asbestos cement and friction materials, whose handling, repair or removal may generate respirable asbestos dust. So we consider next what is perhaps the most difficult of the questions we face: what should be the level to which airborne asbestos dust should be controlled in working environments? Finally we turn to other aspects of worker protection: ventilation, protective clothing, respiratory protective equipment and medical surveillance.

Prohibition

141 As a general principle we take the view that control of any useful but hazardous material is preferable to the ultimate sanction of prohibition. It is very easy to say that a dangerous substance or process should be banned and to hope that that will solve the problem. In our view this is a gross over-simplification of a complex equation of interlinked factors. It ignores the possibility that prohibition of a particular substance may directly result in an increase in health or safety risks, for example from fire, which the use of that substance currently prevents or reduces. It also ignores the implications of statutorily enforcing substitution by materials or substances which at present appear to be suitable but may at a later date be found to constitute a risk to health. The social and economic consequences of the possible closure of factories using the original material or process need to be taken into account.

142 For these reasons, the prohibition of a particular substance or process is not a course of action that can or should be undertaken lightly. There may, however, be circumstances where it can be justified and should be done, taking account of specified criteria. We have examined all the evidence very carefully to identify as candidates for prohibition particular types of asbestos and particular processes where it was clear that:

(a) there was evidence of serious risk and

(b) the present controls or any future controls have not provided or were unlikely to provide a satisfactory degree of control.

The application of asbestos in thermal insulation and by means of spraying both, we concluded, came into this category. Moreover the risk was so high that we deemed it appropriate to make special recommendations on this subject in our first report.

143 In paragraph 115 (Chapter 3) we explained why we believe that crocidolite has caused a serious risk to health and we take the view that human contact with crocidolite should be limited to the minimum reasonably practicable. We have been assured that to all intents and purposes no raw crocidolite fibre is or has been imported into the United Kingdom for some time because of the stringency of the existing 0.2 fibre/ml limit. No data is yet available to show whether this current hygiene standard is effective in preventing ill health from this cause so we are unable to say whether this standard, and the precautions associated with it, will in the future provide a satisfactory degree of control. While the effect of this hygiene standard has constituted an effective voluntary ban on the importation of raw crocidolite, we consider that it would be prudent to reinforce this voluntary cessation of imports by an explicit legal requirement to prevent the importation of raw crocidolite which should also be extended to include manufactured goods in which crocidolite is contained.

Recommendation 1: we recommend that there should be a statutory ban on the import of raw crocidolite fibre to prevent its reintroduction into the UK and that this should be extended to the import of products containing it providing the practical difficulties can be overcome. We stated above that this ban should extend to manufactured products containing crocidolite as well as to the raw material itself. This amounts to a ban on the importation of all such products into the United Kingdom. We recognise that the proportion of crocidolite in the finished products can vary widely, so that such a ban would present substantial enforcement difficulties; for example, it is hard to tell whether a given fibrous material contains crocidolite or whether a particular product contains it, perhaps as an ingredient of one component. We are nevertheless convinced that the justification in principle for the ban that we recommend warrants vigorous efforts to overcome any difficulties of implementation. It is possible, for example, that such a ban would be more practical if a labelling scheme such as we discuss in the next chapter could be made effective on imported products.

Identification of crocidolite in insulation materials and sprayed coatings

144 In our first report we made a number of recommendations about work involving sprayed coatings and insulation materials containing asbestos. It has been pointed out to us that we did not deal directly with the definition of crocidolite and the legal aspects of determining before work starts whether these materials contain crocidolite. It has also been suggested to us that we should define more precisely the term 'containing crocidolite', since different methods of sampling (x-ray diffraction, optical microscopy and electron microscopy) will yield different results. There are several related aspects in the identification of crocidolite which have proved difficult in practice: the proportion of crocidolite which needs to be present in a sample before the regulations apply, the methods of taking a representative bulk

sample from which this can be ascertained and whether all the precautions taken for large scale work on crocidolite should also apply to minor repair and similar work.

Recommendation 2: we recommend that the term 'containing crocidolite' should be defined and that the definition should specify the technique or techniques of analysis to be used and the criteria for deciding whether crocidolite is present.

145 One approach would be to require analysis of all such materials containing or suspected to contain asbestos to determine the asbestos type. This requirement is already implicit in Regulation 6 of the Asbestos Regulations 1969, inasmuch as notice has to be given to HMFI of all work involving crocidolite. Many responsible building and demolition contractors already carry out bulk sampling before they start work involving materials known or suspected to contain asbestos, and either notify HMFI or not according to whether crocidolite is found. The main practical problem arises with jobs where the quantity of the suspect material is so small that to treat it as containing crocidolite (that is, to use more stringent safety precautions) is cheaper than to have the material sampled and analysed. We understand that some firms already choose the cheaper alternative in such cases: that is, when in doubt, they treat the material as crocidolite and notify HMFI. For smallscale jobs, we consider this approach sensible.

Recommendation 3: we recommend that, if as at present an employer chooses to treat a given substance as containing crocidolite, he should continue to be under no obligation to carry out tests to determine whether crocidolite is in fact present.
On the other hand, we believe that the obligation implicit in Regulation 6 should be strengthened.

Recommendation 4: we recommend that, if an employer does not treat a substance as containing crocidolite, the onus should be on him to show that crocidolite is not present if his action is challenged.
Currently the only satisfactory way of discharging that obligation in respect of old lagging or sprayed coatings is by bulk sampling and laboratory analysis. In future years, when Recommendations 1 and 2 of our First Report are implemented so that asbestos is banned in insulation and sprayed coatings, it may be sufficient for an employer to show proof that the material was installed after the ban came into effect. Meanwhile the Code of Practice also recommended in our First Report will give practical guidance on work in those areas.

Substitution

146 We now turn to those types of asbestos and products containing it for which we consider that the ultimate sanction of prohibition is not justified by the evidence at present. All processes involving the use of these fibres and products at work are subject to the Health and Safety at Work etc Act 1974 and most are subject to the Asbestos Regulations 1969. All would be within the scope of the improvements to the Asbestos Regulations that we are now proposing. Nevertheless we feel that something more is needed than a mere tightening of measures to protect workers exposed to asbestos dust in the workplace, or a more rigorous enforcement of these matters. Where a substance such as asbestos has no clearly defined threshold concentration below which the health risk is non-existent there are obvious advantages in replacing it with an alternative material, provided that alternative is significantly less hazardous.

147 While the evidence so far available indicates that the most commonly used man-made mineral fibres are less harmful to man than asbestos, animal experiments suggest that any ill effects from such fibres are related more to the size and shape of the fibre than its chemical composition. It follows therefore if the size and shape of fibres of materials used as substitutes for asbestos are similar to those of asbestos there may be a potential risk. This is therefore an area in which one should proceed with caution.

148 We have been advised that it is doubtful how far Section 2 of the HSW Act can be taken to require an employer to use a less hazardous substance in place of asbestos even if it is reasonably practicable for him to do so. Because of this doubt, we concentrate here on the principles of possible requirements on substitution without considering in detail how they might be fitted into the framework of existing health and safety legislation or, indeed, to what extent they are already implicit in that legislation. We urge, however, that our recommendations should be implemented in such a way as not to weaken any such implicit requirement. We also emphasise that none of our recommendations should be implemented in such a way as to require the precipitate substitution of asbestos or products containing it by alternative materials whose safety is itself unknown or in serious doubt.

149 We have considered carefully two possible approaches, which are not mutually exclusive. The first approach would be to adopt a system of gradual compulsory substitution. This would mean that the whole range of asbestos products would need to be examined periodically by a central authority (HSE) to identify appropriate candidates for substitution. This examination would involve considering factors such as the health risk associated with each product in both manufacture and subsequent use, its economic importance, the availability of substitutes, their relative performance and cost and the health risk associated with them. Such a scheme would, in effect, amount to a gradual extension of prohibition. It would be substantially similar to the programme for substitution suggested in the TUC's written evidence to the committee and would in our view only be acceptable where the criteria set out in para 142 above applied.

150 The second approach would be to require manufacturers, specifiers and users of products containing asbestos to weigh carefully the risks incurred

against the benefits conferred, without relying on a central authority to determine whether substitution should or should not be required in each individual use. As a contribution to achieve this, an obligation could be placed on any employer who carried on a process involving the use of asbestos or any product containing it to replace the asbestos or the product containing it with a less hazardous alternative, so far as is reasonably practicable. In deciding whether it is reasonably practicable to carry out this substitution, an employer could be required to inform himself and his workforce about the suitability and availability of substitute materials. The effect of this approach would be to encourage substitution in the case of those processes and products where the balance of risk justifies it, while leaving aside, to be dealt with by engineering control, those where substitution is not justified, for one reason or another, at present.

151 These two approaches have complementary advantages and disadvantages. The first would have the obvious merit of providing clear-cut decisions, so that everyone would know where he stood. But, given the wide range of uses of asbestos, it would be an immense task to set up and operate the scheme, since it would require the enforcing authority to monitor in detail all commercial developments over a wide variety of industries. Moreover, since the initiative would rest with the enforcing authority, there would be nothing in the scheme to encourage industry, either manufacturers or users of products containing asbestos, to move along the road to substitution in those products for which suitable safer alternatives had been developed but where HSE had not so far made substitution compulsory.

152 In contrast, the second approach would be more flexible; if significant changes occurred in one or more variable in the risk equation, a re-evaluation would automatically be necessary. Such a case might occur if a manufacturer developed a new material as a substitute for asbestos in some use where no practicable substitute existed at present. Moreover manufacturers would have a commercial interest in publicising their new products and materials and pointing out their implications for potential customers in the light of the employer's duties under the new requirement, so that the initiative in discovering and promoting suitable substitutes would rest with employers and manufacturers rather than with any central governmental authority. On the other hand, with this approach the law would be less clear-cut and therefore harder to enforce, and the duty placed on employers to weigh the risks from asbestos against those from a possibly wide variety of potential substitutes might often present difficulties.

153 There are, however, ways to reduce these difficulties and to combine the main advantages of both approaches.

Recommendation 5: we recommend that an explicit obligation should be placed on any person who produces specifications for or carries on a process involving the use of asbestos or any product containing it to consider the substitution of asbestos by other materials so far as it is reasonably practicable to do so. When doing this he should weigh the relative advantages of asbestos and potential substitutes taking into account current knowledge about potential health risks, suitability in the production and performance of the finished product and costs associated with the change.

154 To make the employer's task easier central guidance should be given.

Recommendation 6: we recommend that the Health and Safety Executive or, the Health and Safety Commission as advised by its Advisory Committee on Toxic Substances, should provide and publish both advice on the general principles involved in conducting the evaluation and data on particular possible substitutes so that employers can better fulfil their obligations as proposed in Recommendation 5 above.

155 As a first step towards helping HSC/E implement this recommendation, the committee has prepared a technical paper on possible substitutes for certain uses of asbestos which is contained in Volume 2.

156 We suggest also that in weighing the advantages and disadvantages of substitution an employer's obligation should be limited to a consideration of them insofar as they affect or arise from his own work activities. One might take the view that, if the duty on employers were restricted in this way, inadequate protection would be afforded to those using products at work 'downstream' or to individual consumers either at work or in the domestic field. But, once substitution has occurred in the manufacture of products, the balance of the risk equation would swing towards substitution in the use of products downstream and such employers would have great difficulty in justifying not following suit in order to comply with the same obligation. Moreover, the general duties in relation to Section 6 of the HSW Act will still apply to manufacturers etc in respect of articles and substances for use at work.

157 Limiting our recommended employer's obligation only to his direct costs and benefits has been done to facilitate its practical application and enforcement. The duty is tightly framed and will be workable only for costs and benefits which can be identified and forecasted. Although we believe that this will make a significant improvement to living and working conditions, we recognise that the employer's balance of advantage does not include the wider social costs of obtaining, using and disposing of asbestos. These are real but less clearly attributable.

Recommendation 7: we recommend that the Health and Safety Executive or the Health and Safety Commission, when framing its advice and future policy on substitutes for asbestos, should take into account the social costs of obtaining, using and disposing of asbestos as well as costs and benefits which can be more easily identified and forecast.

158 We have therefore alongside the continuing requirement on employers to weigh risks and act

accordingly, a positive commitment by the enforcing authorities to assess the social costs and benefits of substitution.

Control limits: criteria for determination

159 We now turn to those situations where both prohibition and substitution are either inappropriate or (as in the repair or removal of old asbestos-containing products) ineffective in the short term. We have failed in Chapter 3 to identify a threshold below which there is no evidence of adverse effects. Clearly this suggests that there should be a continuing requirement that exposure to all forms of asbestos dust should be reduced to the minimum that is reasonably practicable. We shall return to the interpretation of this requirement in para 166 below.

160 Experience has shown that a general exhortation, by itself, is inadequate and limits on exposure need to be fixed, linked to a specified procedure for measurement, to provide clear levels which must not be exceeded. Confusion sometimes arises from the mistaken belief that such limits are clear lines of demarcation between safety and danger. But such a demarcation is clearly impossible in those cases, of which asbestos is one, where no threshold has been identified. We wish to emphasise, therefore, the limits we propose must be viewed with this knowledge in mind.

161 As there is no apparent threshold below which exposure to asbestos dust entails no risk to human health, we believe that it is inappropriate to continue to control exposure levels in terms of a 'hygiene standard' as has been done hitherto. Such a concept is misleading in the case of asbestos as it implies a level of exposure below which exposure is safe. We have therefore sought an alternative term which more accurately reflects the current state of information, taking account of the medical evidence in Chapter 3 and the ability of employers and others to control and reduce exposure to asbestos dust. As what we are concerned to achieve is the controlled and progressive limitation of the levels of exposure, we propose that in future the term 'hygiene standard' should be replaced by 'control limit'. In our view this new concept is intended to represent a realistic level of airborne concentration of dust, closely associated with the relevant legislation, above which no person should be occupationally exposed.

Recommendation 8: we recommend that the term 'hygiene standard' should be replaced by 'control limit' for the assessment and control of exposure to asbestos dust.

162 We have considered a number of approaches to setting control limits. One possibility is to establish or define an acceptable level of risk in some way related to society's wishes and then to use Table 21 to convert this to a limiting concentration. But we think that society has not yet developed any method or basis for defining acceptability in this sense, and we therefore rejected this approach as unrealistic. We then looked at the possibility of equating the risk of excess mortality from asbestos exposure with other, somewhat similar, risks in the work environment and then selecting a control limit from Table 21. This we rejected because we felt that the costs of reducing risks, even similar risks, will vary widely between industries and if, in the case of asbestos, a further significant reduction of the risk could be achieved at reasonable cost, then we feel that this should be done irrespective of the relative risks and costs in other industries. By the same token, we felt that it would be inappropriate to select control limits for asbestos by trying to equate the cost of control measures with those in other industries.

163 An alternative approach is to identify the concentration of asbestos dust in the workplace at which further expenditure of effort to lower that level is out of all proportion to the reductions thereby achieved in the risk of contracting asbestos-related diseases. If this approach is applied to the processes where reductions are most difficult, the selected level will by definition be achievable there, and all other parts of industry will be able to do better. They will moreover be expected to do better through the requirement set out in our interim statement and considered further below to reduce exposure to the lowest limit that is reasonably practicable. The risk associated with the control limit selected in this way might still be unduly high; to determine this, it will be necessary to return to Table 21 in order to find out whether this risk is commensurate with that incurred in industry and commerce, or whether it will lead to a predicted pattern of future disease incidence among workers in the dustiest processes which will be so high as to be unjustifiable. If this were the case, we would have to recommend that these processes be banned. Even if this is not the case, the obligation remains to reduce dust levels still further in those processes where it is reasonably practicable. It is important to remember that, with this approach, the control limit represents the upper limit of permitted exposure, not a 'safe' level such that, once it is attained, no further improvement in dust control is necessary.

164 We have concluded that, on balance, this last approach, although not ideal, represents the best available solution in a difficult situation. It is obvious from the evidence given to us that any control level based on this approach could vary markedly according to the process considered. For example, dust emissions in the manufacture of asbestos cement sheet are much easier to control (as shown in Appendix A by the reported dust concentrations in the range of up to 0.6 fibres/ml in the early stages of the process and up to about 1 fibre/ml in cutting/handling) than in the manufacture of asbestos textiles (where the dust concentration sometimes rises above 2 fibres/ml and respiratory protective equipment needs to be worn). It would have been possible to suggest a different control level for each of the many processes. But there are several objections to this approach. First of all it

would mean categorising every process. This would be a long task and there is always the possibility that processes could be inadvertently omitted, thereby escaping statutory control. Secondly, it would suggest that a certain level of risk is more acceptable in some processes than others: an impression which we would not wish to create.

165 We therefore believe that it would be better to set, for the whole of the asbestos industry, a single control limit for each type of asbestos, and that this set of limits should be embodied in legislation. This would provide a clear and unambiguous standard which we feel should be achieved in practice whether it is easy or difficult to do so.

Recommendation 9: we recommend that a single control limit for each type of asbestos should be applied to all processes involving asbestos or products containing it, and that this set of limits should have legal backing.

166 Possible approaches to regulating the more difficult processes are considered further in paras 197 and 211 below. However we wish to avoid a situation where a control limit intended as a maximum can be met easily and serves to discourage further efforts to reduce exposure. Indeed we recognise that in such cases a control limit could have a perverse effect and lead to reduced vigilance on preventive and precautionary measures. There should therefore be a requirement overriding the control limit to ensure that better dust control continues to be sought and obtained in processes which can be more easily controlled.

Recommendation 10: we recommend that legislation should be prepared making clear that an overriding requirement to reduce exposure to asbestos dust to the minimum that is reasonably practicable should be applied in conjunction with Recommendation 9.

Control limits: sampling and evaluation

167 Before any figure can be set for a control limit, the method of sampling and evaluation must be defined. In our second report we recommended that the membrane filter method should continue to be used until better methods were available. The Central Reference Laboratory, which we also recommended, has been set up and is working to produce a standard method for the evaluation of samples which will be described by the HSE in a guidance note specifying evaluation procedures precisely and unambiguously.

168 In Chapter 3 we drew attention to the difference between personal and static sampling. Dr Steel, in Volume 2, shows that the ratio between result of personal and static sampling at textile processes varies within a range of about 0.5 to 17 depending on the process but only rarely (generally when dust levels are low) is the result of a personal sample less than that of a static measurement.

Recommendation 11: we recommend that, for the purpose of assessing compliance with control limits, industry, enforcing authorities and others should use personal sampling employing the membrane filter method.

169 This is not to say that static sampling using the membrane filter method, instruments providing continuous readouts or others, are unnecessary or without value for assessing general background contamination, for assessing levels at particular points in the workplace or for identifying and locating plant failures. All these techniques have their place, but for testing compliance with control limits we think personal sampling using the membrane filter method should be used. We do not suggest that such tests should be carried out all the time at all jobs; the appropriate frequency will vary from one job to another.

170 All our estimates of ill effects from asbestos are based on the long term cumulative intake. To be completely sure of assessing a worker's long term cumulative intake it would be necessary to have him wear a personal sampler all the time he is exposed to asbestos dust. This is quite impracticable, and it is necessary to find some compromise by selecting a duration of sampling time which will give a reasonably representative indication of the dust levels to which the worker is exposed, and at the same time be a practical proposition on the shop floor and in terms of the resources which need to be allocated to dust estimations.

171 The hygiene standards which the Health and Safety Executive apply at present in enforcing the Asbestos Regulations 1969 and the Health and Safety at Work etc Act 1974 are set out in the HSE's Guidance Note EH 10. Currently the limit for crocidolite is based on a ten minute sampling time, while for other types of asbestos limits are set for both any four-hour period and any ten minute period. But there is a variation of concentration in a workplace with both time and position, so that the effect of ensuring that each worker is never, or only very seldom, exposed to dust in excess of the appropriate limits over any period of four hours or ten minutes is to hold longer-term average exposures to a lower level. The amount by which longer-term exposures are reduced at a given workplace depends on how variable the dust samples at that workplace are and how closely the proportion of samples complying with the limit approaches 100%. For example, the long term average sample is likely to be lower than the occasional high short term sample by a factor of about 2 or 3 in very uniform conditions and perhaps lower by a factor as great as 10 if the variability is great and the control limit is vigorously applied so that it is very rarely exceeded (see Appendix M).

172 For operational and enforcement reasons it is not easily practicable to set limits related to periods of more than about four hours. The implication is that the long-term average exposure would thereby be held between 2 and 10 times below the control limit applicable for this period.

Recommendation 12: we recommend that the control limit for each type of asbestos could most reasonably be applied to the result of measurements taken during a four hour sampling period.

173 Even then there are problems of control when short tasks are undertaken in several locations within a single shift and there are other situations (such as may occur on building sites) where a shorter sample is either unavoidable or more appropriate. In these cases a suitable sampling regime to be used in any particular case should be the subject of consultations between the factory inspector, employer and workers' representatives concerned and the results of sampling made available to the workforce.

Recommendation 13: we recommend that where it is not reasonably practicable or appropriate to collect information covering the whole four hour sampling period, the shorter sample decided upon should be treated as representative of the longer period with no concession given to the control limit. Where both four hour and shorter samples are available for the same situation, the four hour sample should be used to assess compliance with the control limit.

This is more restrictive than the current position which provides an increase in the short-term limit by a factor of 6 for chrysotile and amosite. If, however, information applying to the same location and including the same period is available for a longer time, up to a maximum of four hours, then this information should override the short-term result. The control limit would then apply to the longer-term results. Where it is not possible to take samples over a full four hour period, the results from sampling for a shorter time are the only guidance available on exposure levels and their variability. These samples must therefore be used, without concession, to assess complaince with the control limit when necessary or more appropriate to do so.

174 These recommendations should not, however, be taken to preclude the use of short term samples for purposes of process control. Process control includes methods such as segregation, enclosure, and exhaust ventilation, the effectiveness of which employers and workers will wish to measure. Air sampling expressly designed for this purpose is useful to all concerned even if the results do not relate directly to monitoring of occupational exposure. It provides a feedback on the performance of controls and should be regarded as an integral part of the process itself.

175 We have already described in Chapter 3 the effects of the change to modern sampling and evaluation techniques. Taken together, these have the effect of increasing measured fibre counts by a factor between about 2 and 5. Combining this factor with the effect just described of applying the control limit to four hour samples rather than to long-term averages such as those which underlay the British Occupational Hygiene Society's conclusions in 1968, we find that, if a limit around 2 fibres/ml is carefully observed, the exposure of individuals over a lifetime seems likely to be between 4 and 50 times lower than the cumulative exposure estimated to correspond to that dust level in epidemiological studies such as that of the BOHS.

Control limits: application of criteria

CROCIDOLITE

176 We have already recommended a ban on crocidolite in manufacture and on manufactured products containing it. But some crocidolite will remain for a number of years in products likely to release respirable fibres when work is done on them: for example, in sprayed coatings and non-rigid pipe and boiler lagging, which were the subject of our first report. We therefore need to recommend a control limit for the protection of workers in contact with these products.

177 In 1969, HMFI adopted a limit for crocidolite of 0.2 fibres/ml averaged over ten minutes. This is one tenth of the four hour limit set for chrysotile and amosite, in recognition of the evidence then available of a special link between crocidolite and mesothelioma. We are advised that this level can be achieved scarcely anywhere by engineering controls. Nearly all processes involving crocidolite where the Asbestos Regulations 1969 apply therefore bring Regulation 8 into play: that is, workers must be supplied with protective clothing and approved respiratory protective equipment. The same obligation is enforced under Section 2 of the HSW Act in places which do not come within the scope of the Asbestos Regulations. The provision of protective clothing is discussed in more detail in paras 226–229 below.

178 No information is available on either the levels of exposure or the effects on the health of people outside the controlled working area and we therefore have no evidence on which we could recommend a change in the control limit at present. We do, however, propose that the sampling period should, as for chrysotile and amosite, in future be four hours in line with our recommendations 12 and 13 above. This relaxation of the current hygiene standard is more apparent than real, in view of the special precautions for working with crocidolite and the guidance on implementing our earlier recommendations.

Recommendation 14: we recommend that the control limit for exposure to dust from activities involving crocidolite should be 0.2 fibres/ml for a four hour sampling period, subject to recommendations 10, 12 and 13 above.

CHRYSOTILE

179 If we apply the approach described in para 164 above, our first task is logically to determine, in respect of each process involving asbestos, the point at which any further reduction in airborne dust cannot be achieved with any reasonable further expenditure. But we decided that it would be better to set a single limit for all processes involving asbestos, in manufacture, use and disposal. It seems best, therefore, to seek the limit which meets

the criterion set out in para 163 in those processes which account for the greatest amount of asbestos fibre used in Britain today, and then to consider whether this is widely at variance with the limit one would have chosen if one had applied the criterion to the remaining processes. We must then consider, in the light of Table 21, and para 175 whether this limit is acceptable on other grounds.

180 Before we go further, three points must be made. First, we have not considered those processes which are always so dusty that they cannot come close to meeting even the present 2 fibres/ml standard by means of engineering controls (such as stripping sprayed asbestos coatings, the new application of which we have recommended in our first report should be banned). In these processes, protective clothing and respiratory protective equipment are necessary even now for compliance with the hygiene standard, and would continue to be necessary with any reduced control limit. So, paradoxically, reducing the control limit would have little effect on the cost of carrying out these very dusty processes. The processes for which questions of cost arise are those for which meeting a reduced limit by means of engineering controls is at least a *prima facie* possibility, and it is these processes that we shall concentrate on.

181 Secondly, although we discuss below the impact of a reduced control limit on individual processes, we understand from HMFI that the variation in dust levels at a single given process as carried on at different factories is often greater than the difference between the mean dust levels for different processes. Even in respect of a single process, therefore, the economic impact of a reduction in the limit would be very different in different factories. Thirdly, HMFI tell us that the stage has been reached in many workplaces where the way to achieving the greatest reductions in airborne dust levels is not the introduction of improved exhaust ventilation but through discovering and encouraging the work practices which generate the least dust. Ergonomics is therefore also important in controlling dust levels.

182 The processes which account for the greatest amount of asbestos fibre used in Britain today are those involved in the manufacture of asbestos cement products. These accounted for more than one-third of the asbestos imported into Britain in 1976 (Chapter 1, Table 6). We will therefore, as an example of our general approach, apply to asbestos cement products the tests set out in paragraph 163 above to illustrate how we approached our recommended control limit for chrysotile asbestos.

183 In manufacture, employers tell us that while current levels may vary considerably between factories, dust concentrations at the majority of operations are below 1 fibre/ml, common exceptions being fibre blending and various cutting and sawing operations and about 70 per cent at finishing operations were less than 0.2 fibres/ml although some others exceeded 1 fibre/ml.

184 Employers tell us that to reduce counts universally to 1 fibre/ml on a four hour time weighted average (TWA) basis in manufacturing operations would require a capital investment in extra extraction equipment and other adaptations of £500 000 and additional running costs of between £120 000 and £150 000 a year (bringing total running costs to £300 000). This would put the price of asbestos cement products up by about 1½% and result in some loss of market share. Allowing for reduced productivity, the full increase in price has been estimated at between 3 and 5%. Employers conclude that in the manufacture of asbestos cement products it would be practicable to achieve a 1 fibre/ml standard at a cost they could meet – but they estimate it would take 18/24 months to install the necessary equipment.

185 On the other hand, to reduce the control limits substantially below 1 fibre/ml in the manufacture of asbestos cement products would, we are told, pose much greater difficulties. In the case of many of the older plants, manufacturers doubt whether a further reduction could actually be achieved by means of engineering controls and some plants would need to be closed. Where it might be possible, they estimate that the cost might be of the order of £1 000 000 and about five years would be required for implementation. A reduction in United Kingdom production would result and where these materials continue to be used there would be an increase in imports.

186 It is much more difficult to assess the problems of implementing more stringent control limits in the use of asbestos cement products, particularly in construction work as dust concentrations measured on the basis of a four hour TWA depend largely on the type and duration of the operation, whether hand or power tools are used, whether the work is damped, and whether it takes place in the open air or in a confined space. Machine sawing of asbestos cement products without exhaust ventilation can give rise to dust levels of up to 20 fibres/ml during the operation and even hand sawing for a period of four hours (an unlikely event) will produce levels of the order of 2–4 fibres/ml. However if hand sawing is only carried out for ten minutes in the open air and the worker is not exposed to other sources of asbestos dust for the remainder of the period the four hour TWA exposure can be reduced to about 0.1 fibre/ml. Similarly effective local exhaust ventilation for power operated saws and water sprays for cutting pipes can reduce dust levels to below 2 fibres/ml over a four hour period.

187 Employers take the view that in the use of asbestos cement products in new buildings and works, the current 2 fibres/ml standard can be met but with some difficulty. A reduction to a TWA of 1 fibre/ml over four hours need cause no problem in outdoor work nor in indoor work which is generally intermittent provided that hand tools are used. However they foresee difficulties in persuading workers to reduce exposure by these means. Similar arguments apply to obtaining the necessary reduction in exposure by the use of dust respirators or the provision of

exhaust ventilation on portable power tools. No difficulty is envisaged in meeting a 1 fibre/ml four hour TWA control limit in repair and maintenance work because of the short time involved.

188 Employers however, conclude that a more stringent control limit than 1 fibre/ml in the use of asbestos cement products in new construction work is not practicable. Their views are not based on the conclusion that it is not technically feasible to reduce exposure still further by the provision of engineering control or by the provision of personal protective equipment but on the belief that these measures are likely to be unacceptable and unenforceable in the particular conditions pertaining on construction sites. They take the view that the effect of a more stringent standard than 1 fibre/ml over four hours would would probably result in the abandonment of asbestos cement products for construction.

189 We conclude, on the basis of the evidence available to us, that it should be possible within eighteen months or so for industry to take the steps necessary to comply with a more stringent control limit of 1 fibre/ml on the basis of a four hour TWA which the whole of the asbestos cement manufacturing industry can reach. Such a limit should be achievable too, in the use of asbestos cement products in the construction industry but this will clearly need an effective programme in training and education of management and employees to ensure that proper precautions are observed. This would be facilitated by the development of more sophisticated engineering controls for portable tools which are both more efficient and convenient for use.

190 While it is obviously practicable to reduce exposure still further in certain processes in manufacture, we accept that there are considerable technical and human problems in doing so in other fields, particularly in the use of asbestos cement products in construction. Any further reduction in airborne dust levels would involve very much larger expenditure and a longer time scale to implement. In some areas employers take the view that further reductions are not technically feasible.

191 From a similar examination of other parts of the asbestos industry, it appears that a control limit of 1 fibre/ml is already or might in the near future be attainable for most processes and products. More detailed information for individual cases is given in Appendix N which should be read with Appendix A. The committee does not necessarily accept without question the costs estimated by employers of meeting such a revised control limit. All costs quoted are for 1976. Figures supplied by the industry suggest that it would be reasonable to increase all stated costs by a minimum of 10 per cent per annum to take account of inflation.

192 From the review of the likely impact of a four hour TWA of 1 fibre/ml limit (see Table N2) it seems likely that considerable difficulty would be experienced in the manufacture of asbestos textiles and friction materials. This would indirectly affect the cost of processes and products where these components are used. But, on balance, we consider that the problems that are likely to arise, when compared with the benefits in terms of a reduction in the health risk, are not serious enough to deter us from our preference for the early introduction of an industry-wide control limit of 1 fibre/ml for chrysotile. It remains, therefore, to determine whether the risks of disease at 1 fibre/ml is unjustifiably high among workers exposed to asbestos dust.

193 To do this we must turn to Table 21 which shows the dust concentrations that would probably produce the shown excess mortality from lung cancer after 50 years exposure according to linear dose response models – 50 years being likely to provide a considerable safeguard because, in the future, shorter working weeks and reductions in overtime are likely to affect materially the accumulated exposure. But to determine the effects of a given control limit, the results need to be expressed the other way round. Table 24A is interpolated from Table 21, which shows that the total excess mortality from lung cancer and asbestosis caused by 50 years exposure to an average level of 1 fibre/ml might range from 0.4 % to 5 % of those exposed at that level assuming excess mortality can be attributable equally to lung cancer and asbestosis. The results thus depend critically on the conversion factors employed. The worst case is represented by the Rochdale data. But this takes no account of the improved dust sampling and counting techniques and changing smoking habits.

194 We propose here to disregard the differences between personal and static sampling which if included might appear to reduce the risk estimate. Nevertheless we must take account of the modern counting methods by applying a factor of about 2. This would suggest that, in a population exposed to 1 fibre/ml for a period of 50 years, the excess mortality might be in the range of 0.2 – 2.25 %. If a 1 fibre/ml limit is observed strictly during short sampling periods, it is appropriate to apply the factor suggested in para 171 to calculate the effect on long-term exposure. This factor was stated to be about 2 or 3 in workplaces where dust conditions are uniform and about 10 where the variability is great and compliance is strict. The excess mortality predicted for those exposed to these levels for 50 years is therefore likely to be within the range of about 0.2 % and 1.25 %, according to the nature of the process and the level of achievement in complying with the limit. Not all asbestos workers will, by any means, be exposed at the control limit level for 50 years, and through all these calculations it is important to bear in mind the qualifications given in paras 87–91 and Table 17 of Chapter 3.

195 It seems clear, then, that a control limit for chrysotile based on a four hour time weighted average (TWA) of 1 fibre/ml could be introduced with a consequential reduction in asbestos related disease at the economic and social cost set out in this chapter and in Appendix N. It could be implemented fairly quickly; for example, industry suggests that the observance of a 1 fibre/ml level in asbestos cement products could be achieved in 18–24 months, although some processes and

Table 24a Estimated excess mortality after 50 years exposure to 1 fibre/ml chrysotile. (Interpolated from Table 21)

Study	*Conversion† factor*	*Excess mortality from lung cancer* (%)	*Total* excess mortality* (%)
Quebec	5	0.2	0.4
	2	0.5	1.0
	1	1	2.0
Enterline (production workers)	5	0.4	0.8
	2	1	2
	1	2	4
Rochdale	—	2.5	5.0
	2	1.5	2.5
	5	0.5	1.0

*Assuming mortality from exposure to chrysotile can as an approximation be attributed equally to lung cancer and asbestosis.

†See Table 21.

sectors of industry present more difficulties. With allowance for consultations on this report and subsequent regulations as well as the industry's own adjustment, we believe it is possible to propose a practicable timetable in the near future for the limit to be introduced.

Recommendation 15: we recommend that the control limit for exposure to dust from chrysotile asbestos should, with legal backing, become 1 fibre/ml by 1 December 1980, subject to Recommendations 10, 12 and 13 above.

196 There are many processes with average dust levels already at or near 1 fibre/ml where compliance with such a limit will present little or no difficulty. At some processes where typical dust concentrations are now above 1 fibre/ml it may be relatively straightforward to achieve compliance by devising and introducing intrinsically less dusty working methods without having to make large changes in exhaust ventilation systems. This is especially likely to be true of the handling, inspecting and packing of finished products such as asbestos insulation board. We recognise, however, that some processes will probably remain (eg in asbestos textile manufacture) where, even when all practicable steps to reduce dust are taken, compliance with a 1 fibre/ml four-hour TWA control limit will not be feasible by 1980. Since we would not wish our proposed time scale to be applied so inflexibly that these processes are forced to close down, this presents a problem.

197 We have considered three possible approaches: (a) exempting specific processes from the new control limit, (b) applying the limit to different processes according to different time scales, and (c) enforcing the limit flexibly. The third approach has the advantage of avoiding the need to identify explicitly in advance those processes to which an exemption or deferment would apply – potentially a difficult exercise, given that, as we have said, differences in dust levels between factories are at least as great as differences between processes. But, while we would expect the Factory Inspectorate or any other enforcing authority to use discretion and common sense in enforcing any new control limit, just as they do with all statutory requirements of health and safety legislation, we think that to rely entirely on this approach would be unsatisfactory. It would impose on the Factory Inspectorate the burden of deciding where leniency was justified and where it was not, and would leave employers and employees in doubt about precisely how the law was to be interpreted in relation to their own workplaces. On the other hand, the first approach (that of exempting some processes from the scope of the new limit) is unacceptable because it carries greater risks than others. This implication could be avoided only if each exemption were linked to an expiry date. This approach would then be virtually indistinguishable from the second that we considered: specifying different time scales for different processes to comply. On balance, we favour this alternative.

Recommendation 16: we recommend that the HSE should examine with representatives of the employers and employees concerned those particular processes where there appear to be difficulties in meeting the timetable recommended for the application of the control limit for exposure to dust from chrysotile asbestos.

198 In looking at these processes, all parties will need to bear in mind, as an alternative to deferring the application of the new limit to a given process for a few months, the possibility of relying on respiratory protective equipment and protective clothing as a 'second best' method of securing compliance, especially for processes where individual workers are exposed only occasionally to relatively high dust concentrations.

AMOSITE

199 We have also considered the control limit for amosite. Many of the longer term uncertainties surrounding chrysotile apply to amosite, so what we say in paras 212–218 below will apply to both. Looking to the shorter term, the principal difficulty in interpreting the effects of amosite upon health is that very few definable groups of workers have been exposed to amosite who have not also been exposed to crocidolite, particularly in the UK, or chrysotile, particularly in the USA.

200 As an example, for reasons developed in Volume 2 (Relationships of medical effects to fibre type) we consider the majority of the cases of mesothelioma reported in insulators in the USA have probably been associated with exposures to mixtures of amosite and chrysotile. However, eleven mesotheliomas were reported among 933 workers in a factory making insulation material from amosite and there are four well attested cases of mesothelioma diagnosed for domestic contacts of workers with amosite.

201 Evidence of the ability of amosite alone to produce lung cancer draws on the experience of the workers at a factory in the USA which manufactured insulation materials (see Reference 21, Chapter 3). This study shows excess risks of lung cancer after very short exposures to amosite dust (see Table 16, Chapter 3) and, although quantitative measurements of dust

concentrations are not available and the observation has been made in only one study, the most likely inference is that the risk of lung cancer for men exposed to concentrations of amosite asbestos was higher than that for men exposed to similar concentrations of chrysotile dust. Exposures of insulators in the USA to concentrations of mixed amosite and chrysotile dusts have also been associated with very high relative risks of lung cancer.

202 From this and other information given in Chapter 3 and Volume 2, although there are no strictly quantitative data, the medical evidence suggests that amosite has been probably more dangerous than chrysotile but less dangerous than crocidolite in respect of mesothelioma and possibly also in respect of lung cancer. We therefore believe that for the short term a control limit should be recommended which is lower than that for chrysotile but above that for crocidolite, that is, between 1 fibre/ml 4 hour TWA and 0.2 fibres/ml 4 hour TWA.

203 Employers have said that the effect of such a limit would be to put an end to the use of amosite in the UK. This would affect two types of product: insulation boards for fire protection and asbestos cement pipes.

204 Employers have told us that a control limit in the near future of below 1 fibre/ml 4 hour TWA would constitute an effective ban on the use of amosite in the manufacture of insulation board, and this with a reduction in the control limit for chrysotile to 1 fibre/ml 4 hour TWA would almost certainly lead to the withdrawal of insulation board containing asbestos from the market and its immediate replacement by other products. They believe that a further reduction is not technologically feasible to comply with at present.

205 In the employers' view particular problems would be encountered in trying to comply with a reduced limit during installation and use of insulation boards on site. Employers have told us that even if the manufacturing processes could be adapted to comply with a more restrictive limit, the inability of users to do so would render sales and thus production impossible to maintain. They believe compliance would be impossible to achieve on site by the use of engineering controls alone and consider that the adoption of our recommmended limit would necessitate substitution of asbestos products in this field.

206 For asbestos cement employers have told us that the position is more complex. The special characteristics of amosite fibre are held to improve technical performance and facilitate manufacture so that higher productivity can be achieved rather than being an essential component of the finished product. Without amosite it may still be possible to produce small diameter asbestos cement pipes, but only at a slower speed and consequentially greater cost. We have been told that the manufacture of large diameter pipes would be uneconomic without amosite, and that this part of the UK industry could cease to exist if a control limit below 1 fibre/ml 4 hour TWA was introduced.

207 We have paid particular attention to the availability and suitability of substitutes for amosite asbestos. In respect of fire-resisting insulation boards, the industry has advised us that alternative products not containing asbestos are now in the course of development with good prospects of success in some areas. In other uses, especially those involving thinner materials and applications for high temperature resistance, asbestos is still considered to be an essential component.

208 Employers believe it is economically essential to continue producing asbestos-containing materials in parallel with the development of substitutes. They estimate that the cost of substitutes is up to 30% higher than the asbestos they replace and, in the face of customer resistance, need to subsidise their selling price from sales of the original product containing asbestos to retain a viable market share.

209 Although employers therefore strongly advise against any lowering of the control limit for amosite in the near future, and with some processes (including treatment of raw fibre, sanding, sawing and finishing) occasional counts above 2 fibres/ml can still occur, monitoring of dust concentrations by employers has shown that for a substantial proportion of production processes in insulation board manufacture, exposure levels are being reduced. Measurements taken by HMFI for different employers and jobs support this trend. They show that between 1972 and 1975 about 60% of results in manufacturing and about 35% in finishing of insulation board were below 1 fibre/ml, and samples taken by HMFI in the asbestos cement industry between 1972 and 1975 show 63% of results below 0.5 fibres/ml and 40% below the 0.2 fibres/ml level.

210 Taking account of all the facts before us, including employers' views of the practical and commercial difficulties of taking such a step, we adjudge that at the present time a reduction in the control limit for amosite between that of chrysotile and crocidolite is desirable.

Recommendation 17: we recommend that the control limit for exposure to dust from amosite asbestos should with legal backing become 0.5 fibres/ml by 1 December 1980, subject to Recommendations 10, 12 and 13 above.

211 As with the limit for chrysotile, we recognise that there will remain some processes where, having taken all reasonably practicable steps to reduce dust, compliance with a limit for amosite of 0.5 fibres/ml for the appropriate sampling period will not be feasible in this time.

Recommendation 18: we recommend that the HSE should examine with the representatives of the employers and employees concerned those particular processes where there appear to be difficulties in meeting the timetable recommended for the application of the control limit for exposure to dust from amosite asbestos.

Control limits: a longer-term solution

212 We have suggested in the preceding paragraphs a reduction in the control limits for occupational exposure to chrysotile and amosite, which we suggested should come into effect by 1 December 1980. We now turn to the longer term: the steps to be taken beyond the end of 1980. Here we are less definite. One reason is that the further ahead one looks the more reasonable it is to think in terms of controls extending beyond asbestos to other fibrous dusts which have biological effects similar to asbestos. This committee is not equipped to answer the large questions which arise here, although we suggest in paragraphs 216 and 217 why these questions are important and how they might be tackled.

213 A second reason is that technological change and increased medical knowledge are more likely to render long-term recommendations obsolete than short-term ones. Nevertheless, having said that we are not sufficiently certain about the degree of risk which seems likely to remain even when a 1 fibre/ml and 0.5 fibres/ml limits are achieved, we cannot avoid saying something about how we think that risk might be further reduced, going beyond, if possible, the continuing requirement already recommended to reduce asbestos exposure to the minimum reasonably practicable.

There are also important issues affecting any longer-term solution for asbestos. Some of these issues are scientific; others are social or (in a broad sense) political. We will describe them briefly and suggest how they might be tackled.

214 In discussing a further reduction in the control limit for chrysotile, we mentioned the possibility that new developments in medical knowledge or in sampling and measurement techniques might render obsolete any proposal put forward today for control limits in five or ten years' time. We very much hope, indeed, that such developments will take place, as a result of the research which we recommend in this report and which we recommended in our second report on environmental monitoring. Particularly valuable will be data adequate to provide definitive answers to the following problems:

the relative importance in causing asbestos-related disease of factors such as the individual's long-term cumulative dose, distribution of dust exposure over an individual's working lifetime, the length of time that fibres remain in the lung and exposure to very high peak concentrations;

the relative importance of the physical characteristics of fibres (size and shape) and their chemical characteristics (composition and mineral origin) in determining their biological effect;

the biological effect of fibres outside the size range currently specified by the HSE for monitoring purposes;

the feasibility of setting a control limit based on the individual's accumulated exposure.

215 Answers to these questions may have implications beyond asbestos. If for example, the existing evidence on the importance of fibre size and shape in causing disease is strengthened, decisions about all airborne fibres – man-made as well as natural – may be affected. Several of the products coming into use as substitutes for asbestos-based products contain man-made fibres and it is therefore important that some body of experts should keep a close watch on these developments and make appropriate recommendations. These recommendations might affect the detailed operation of the substitution strategy that we proposed earlier in this chapter, since it would clearly be absurd for the HSE to encourage the substitution of some other fibre for asbestos in some product if there is evidence that that fibre is equally dangerous or even more so. They might also affect the scope of a further control limit for chrysotile: if, for example, the chemical composition of chrysotile were shown to be irrelevant to the risk it presents. It would then be sensible to impose a control limit on all fibres sharing the relevant size and shape distribution rather than on chrysotile alone.

216 It will also be necessary to evaluate the social and economic implications of any new scientific developments. A hazard may be so serious that everyone would agree it must immediately be removed at whatever cost. But the risks arising from most uses of asbestos do not fall into that category. Some forum will therefore be necessary to evaluate any new evidence about the social and economic implications not only of our own longer-term proposals but also of the medical and scientific developments we foresee.

217 What expert body is equipped for this task? Our own terms of reference cover only asbestos and we therefore do not feel that we have either the necessary remit or expertise to conduct a broader investigation. Fortunately, the whole topic falls naturally within the scope of one of the standing advisory committees already set up by the Health and Safety Commission: The Advisory Committee on Toxic Substances. This committee has recently received a report from its Working Party on Man-Made Mineral Fibres, whose findings will be very relevant to the questions we have mentioned about the fibrous substitutes for asbestos, and is therefore well placed to compare the costs and benefits of using different fibrous substances. Since the membership of this committee – like our own – includes not only independent experts but also representatives of employers and employees, it is equipped to consider the relevant social questions as well as the more narrowly scientific ones.

Recommendation 19: we recommend that the Health and Safety Commission should refer our report to the Advisory Committee on Toxic Substances, invite it to monitor and evaluate the results of the research we have proposed, and to review the recommended control limits as further information becomes available.

218 International implications, too, are increasingly important in the longer term. It would be regrettable if British industry, in protecting its employees adequately against risk from asbestos, suffered in competition with firms operating under laxer rules abroad. We have already mentioned the possible effect on the asbestos cement industry of 'going it alone' on amosite. But this is only a single instance of a potentially much wider problem. Conversely, to take advantage of products from abroad whose low cost is achieved at the expense of high risks for the workpeople would also be irresponsible. Efforts should therefore be made to achieve harmonisation of international control limits on asbestos.

Recommendation 20: we recommend that the Government should press for similar standards of control for asbestos with other countries, particularly within the EEC, and through international organisations such as the ILO and WHO, along the lines we have recommended.

Other controls in the workplace

MONITORING

219 By monitoring, in this context, we mean the measurement of asbestos dust concentrations in the air in order to arrive at results which can be used for assessing compliance with a control limit, for checking the effectiveness of dust control measures or for comparison with information on the occurrence of disease in an epidemiological survey. A control limit can be capable of a variety of interpretations unless the methods of sampling and evaluation of the samples are clearly defined. Moreover we consider that in most circumstances an employer cannot be sure that he is complying with the regulations unless monitoring has been carried out. However the need for and the frequency of monitoring depends largely on how often conditions in the workplace change in ways likely to affect the airborne dust concentration.

220 We attach considerable importance to monitoring. Indeed it was for that reason we devoted our second report to this subject. That report describes in some detail the problems of estimating concentrations of asbestos dust and what further work needs to be done. Some is already well under way. All major manufacturers of asbestos products and some other employers have already been carrying out dust estimations for many years. We believe that these developments should be encouraged.

Recommendation 21: we recommend that there should be an obligation on an employer to arrange for dust estimations to be carried out at such places and at such intervals as are necessary for the purposes of (a) ascertaining the effectiveness of his methods of restricting the exposure of employees to asbestos dust and (b) testing the efficacy of engineering methods for the control of dust, especially exhaust ventilation equipment.

221 As we explained in our second report, the techniques used for process control need not be the same as those used for assessing compliance with hygiene standards. For monitoring programmes to be carried out effectively, it will be necessary to specify that both sampling and sample evaluation are done by a person who has had the appropriate training to ensure that the results will provide as accurate an assessment of the risk as possible.

222 Guidance will also need to be given on the equipment used, the methods of sampling and sample evaluation and when, where and how frequently samples should be taken and how and for how long the results should be recorded. But these are matters which we feel should not be specified in the regulations but in supporting publications.

EXHAUST VENTILATION EQUIPMENT

223 The Asbestos Regulations require that unless it is impracticable, no process to which the regulations apply shall be carried on unless equipment is provided, maintained and used which produces an exhaust draught which prevents the entry into the air of any workplace of asbestos dust.

224 We are concerned that there are no standards of emission set for the asbestos dust which might be discharged in the open air and we make proposals to remedy this defect in the following chapter.

225 We have been told that sub-section 3 of Regulation 7, which requires that exhaust ventilation should be thoroughly examined and tested by a competent person at least once in every period of 14 months, is not well observed and it has been suggested that this is mainly due to the fact that the competent person is not always, in fact, competent. If this is so, we suggest that it may be desirable to introduce a requirement to ensure that these persons are trained to a specified standard. A precedent for specifying the standard of approved training is provided by the Power Presses Regulations 1965 and the Abrasive Wheels Regulations 1970.

Recommendation 22: we recommend that, in view of the importance of maintaining and servicing ventilation equipment to a high state of efficacy, people who examine and test it should be trained to a specified standard.

We have not recommended specifically how this recommendation should be implemented but believe that it may be more appropriate to a code of practice than to regulations.

PROTECTIVE EQUIPMENT

226 Approved respiratory protective equipment and protective clothing are already required by the regulations but only where it is impracticable to provide exhaust ventilation equipment which prevents the escape into any workplace of asbestos dust as defined. As we have seen, British manufacturers who used raw crocidolite fibre found the precautionary measures now required excessively burdensome to put into effect and chose

rather to stop using this type of asbestos altogether. But that option was not available to those operations (such as delagging) involving crocidolite-based materials in situ. To comply with the regulations at these operations, employers have no alternative but to supply their workers with protective clothing and respiratory protective equipment.

227 At present the obligation is not stated explicitly in regulations but flows directly from the impossibility of complying with the crocidolite limit by means of exhaust ventilation. The wording is rather obscure, and in any case it has been suggested to us that exhaust ventilation does not always prevent workers' clothing from being contaminated with asbestos dust by, for example, direct contact, even though the control limit may not be exceeded at the time.

Recommendation 23: we recommend that the requirement to provide protective clothing and respiratory protective equipment should be explicitly stated in regulations and extended to include any workers whose person or personal clothing is liable to be significantly contaminated with asbestos dust.

228 We also see a need for giving more explicit information on suitable protective equipment and clothing by means of a guidance note. The corollary to protective clothing is the need for ordinary personal hygiene and the provision of changing and washing facilities. The standards of these facilities required by the existing Factories Act 1961 may be adequate for those asbestos workplaces which are subject to the Act, but we believe that the same standards should be applied to workplaces outside its scope.

Recommendation 24: we recommend that suitable changing and washing facilities should be provided at all places where protective clothing is required.

229 Regulation 19 explicitly requires the cleaning of protective clothing to be carried out within the premises where the clothing is provided with the exception that clothing may be cleaned elsewhere provided it is properly packed in suitable containers clearly and boldly marked 'Asbestos contaminated clothing'. It has been represented to us that this allows contaminated clothing to be cleaned at workers' homes provided of course that the condition in the exception are observed, and we believe that this should be stopped.

Recommendation 25: we recommend that there should be an explicit prohibition on the cleaning in workers' homes of the protective clothing required to be issued for work with asbestos.

ASBESTOS HAZARD AREAS

230 At present the regulations contain no requirement to provide a warning at the boundaries of areas or workplaces where the dust concentration exceeds or is likely to exceed that specified in the control limit (e.g. filter galleries) and where as a consequence personal protective equipment ought to be worn or alternatively access ought to be prohibited. While the provision of warning signs or notices or restriction of access may in many cases only confirm a situation which already exists we believe, on balance, that there are advantages in placing such a duty on employers.

Recommendation 26: we recommend that, so far as is reasonably practicable, areas or workplaces where dust concentration does or is likely to exceed the control limit should be suitably marked and a scheme for restricting access to them instituted.

Medical supervision

231 The Advisory Committee has considered what aims any system of medical supervision for asbestos workers should be designed to achieve, and to what extent the present arrangements described in Appendix L achieve them.

We believe that the aims should be twofold:

to protect individual workers;

to collect data which can be related to information about dust exposure for use in epidemiological studies and in assessing the long-term effectiveness of control measures.

232 The first aim seems obvious. But it is still uncertain how far medical supervision can improve the outlook for individuals. There is regrettably no substantially effective treatment for mesothelioma and as for lung cancer there is no evidence that people discovered to have the disease by routine screening, before symptoms have appeared, survive longer as a group than people diagnosed after symptoms have appeared. As for asbestosis and other conditions such as pleural thickening, it is known that in some patients these conditions continue to develop even if they are removed from exposure as soon as the earliest signs are observed, although there are also many patients in whom no progression is observed. There is no way of identifying in advance individuals who are particularly susceptible to asbestos exposure (in the absence of already serious respiratory illnesses such as tuberculosis) and it is not known whether early removal from exposure of those with diagnosed asbestosis makes any difference to a person's later medical history. Nevertheless, we conclude that a system of regular medical supervision can fulfil useful functions from the individual worker's point of view, namely:

it provides workers with objective information about their present state of health;

by alerting the worker and his employer to any early indications of disease, it enables him to benefit to the greatest extent possible from any advantages there may be in ceasing further exposure to asbestos dust;

it provides opportunities for doctors to encourage workers with an asbestos-related disease to apply to be seen by a Pneumoconiosis Medical Panel and make a claim for disablement benefit if the disease is confirmed;

the medical record which is built up for each worker may help doctors to apply to him effectively any new treatment which is discovered in the future;

it provides opportunities for doctors to warn workers of the greatly increased risk of lung cancer for people exposed to asbestos who also smoke.

233 We have already drawn attention in Chapter 3 to the synergistic effects of smoking and exposure to asbestos dust. Many employers already advise their workers of this inter-relationship and, duly recognising the relevant social factors, we believe that their efforts should be increased to dissuade workers from smoking at least during operations involving work with asbestos. Safety representatives and safety committees have an important role to play in this respect.

Recommendation 27: we recommend that all people whose work is liable to expose them regularly to asbestos dust should be advised to refrain from smoking.

234 A system of medical supervision which fulfils the aims set out in para 231 above will, we believe, have the following features:

(a) a single organisation will be responsible for running the system and for seeing that medical records are maintained;

(b) employers will be legally required to inform the organisation of anyone currently in or entering employment where precautionary measures have to be taken regularly to ensure compliance with the Asbestos Regulations and to provide facilities for him to be medically examined;

(c) workers will undergo an initial examination on entering employment and periodic examinations thereafter at appropriate intervals determined by the organising body but probably not greater than two years;

(d) the worker, the overseeing organisation and (if the worker agrees) his employer, his general practitoner and the works medical officer (if any) will be informed of any adverse effect discovered in the course of an examination;

(e) the causes of death of workers involved will be recorded so that the epidemiological aim of the scheme can be achieved;

(f) records will be kept in a form suitable for fulfilling both the stated aims (individual protection and epidemiology) including, e.g. as much information as is reasonably practicable about exposure to asbestos dust.

235 Currently, two organisations EMAS and the Pneumoconiosis Medical Panels (PMPS) operate systems of medical supervision involving periodic examinations, see Appendix L. Neither of these two systems has all the features just listed. In particular, the fact that two organisations are involved conflicts with the first specification and, although there is co-operation between the two bodies, administrative arrangements to avoid duplication are not uniform throughout the country. We therefore conclude that present arrangements do not adequately achieve the aims we have set out.

Recommendation 28: we recommend that the two existing schemes of medical supervision should be replaced by a single one with the features listed in para 234.

236 We consider now how this recommendation might be implemented. An initial caveat is necessary: our suggestions on this are more tentative, since we do not believe it is for us to work out in detail how a new system of medical supervision of the kind we recommend should be administered. We would look to discussions between the interested parties, including the two existing organisations, the Department of Health and Social Security, the Scottish Home and Health Department and the respective health authorities to help ensure that the new organisation is effective and that the necessary facilities are made available.

237 We do, however, believe that the operation of medical supervision at the workplace needs to be reinforced.

Recommendation 29: we recommend that a regulation should be made under the Health and Safety at Work etc Act requiring employers to co-operate in the EMAS survey, by informing EMAS of anyone currently in or entering employment where precautionary measures have to be taken to comply with the Asbestos Regulations and provide facilities for him to be medically examined. The regulation would make clear that responsibility for the medical supervision of his workers rests with the employer who must conduct it to the satisfaction of the HSE. Where the employer himself does not have appropriate facilities for carrying out the examinations, he can ask EMAS to do so but the responsibility for and the costs of the operation remain with the employer.

238 On the other hand, we believe that workers should not be under any corresponding obligation to submit themselves for examination if they prefer not to. The new regulation will need to specify that such refusal to be examined does not constitute a breach of Section 7(b) of the HSW Act (which requires employees to co-operate with employers so far as is necessary to enable them to perform their duties under health and safety legislation).

239 The EMAS survey already covers all those asbestos workers subject to the requirement for initial and periodic medical examination set out in the Social Security (Industrial Injuries) (Prescribed Diseases) Regulations 1975. We therefore propose that this requirement should cease. This, of course, would not affect the role of the PMPS in hearing claims for disablement benefit from people who have been exposed to asbestos.

Recommendation 30: we recommend that if Recommendation 29 is implemented the requirement for initial and periodic medical examination of asbestos workers under the Social Security (Industrial Injuries) (Prescribed Diseases) Regulations 1975 should be repealed.

240 Although we recommend that a single organisation should run the system of medical supervision for asbestos workers and suggest that this organisation should be EMAS, we do not recommend that only Employment Medical Advisers should carry out medical examinations within the system.

Recommendation 31: we recommend that the EMAS should have the power to authorise doctors other than their own staff to conduct the medical supervision of asbestos workers, subject to suitable training and guidance.

These other doctors could include privately employed industrial medical officers and PMP doctors, although in view of the PMP's quasi-judicial function in dealing with compensation claims safeguards may be needed against any real or suspected conflict of roles.

Appendix L

Present legal and administrative controls at the workplace

L1 In this Appendix we describe existing legislation dealing with asbestos in the workplace. The Acts and Regulations which are of potential relevance (all of which are enforced by either the Health and Safety Executive, the Railways Inspectorate or Local Authorities) are: the Factories Act 1961 and Asbestos Regulations 1969, the Mines and Quarries Act 1954, the Agriculture (Safety, Health and Welfare) Act 1956, the Offices, Shops and Railway Premises Act 1963 and, perhaps most important, the Health and Safety at Work etc Act 1974. Information in this Appendix has been supplied by the Health and Safety Executive.

FACTORIES ACT 1961 AND ASBESTOS REGULATIONS 1969

L2 The Asbestos Regulations 1969 were introduced to replace the Asbestos Industry Regulations 1931 mainly because the earlier regulations did not cover many of the processes where risks to health from asbestos existed. The 1969 regulations apply in certain premises where the Factories Act 1961 applies and are in substitution for the general requirements on dust stated in Section 63 of the Factories Act.

L3 Asbestos is defined in the regulations as meaning crocidolite, amosite, chrysotile, fibrous anthophyllite or any mixture of these. Actinolite and tremolite are not covered. The regulations apply in factories, in places where building, building repair or demolition are carried on, and to civil engineering work such as the construction, structural alteration, repair or demolition of docks, tunnels, bridges, pipelines, etc, electrical generating stations and ships in harbour or wet dock, unless the work is undertaken by the master or crew.

L4 The regulations apply only to processes involving asbestos, in which asbestos dust can be given off. Fundamental to the regulations is the interpretation of the term 'asbestos dust'. This is defined as dust consisting of or containing asbestos to such an extent as is liable to cause danger to the health of employed persons. The Health and Safety Executive's Guidance Note EH/10 ('Asbestos: hygiene standards and measurement of airborne dust concentrations') gives guidance on the criteria that the HSE uses in assessing whether or not there is compliance with the regulations. The Note states that dust exposure should be reduced to the minimum that is reasonably practicable and in any other case, occupational exposure to crocidolite should never exceed

0.2 fibres/ml when measured over any 10 minute period, while for other types of asbestos the hygiene standard currently in use is 2 fibres per millilitre averaged over a 4-hour sampling period or 12 fibres per millilitre averaged over a 10-minute sampling period.

L5 The main requirements of the regulations are:

(a) Before any process involving crocidolite is begun (including the removal of lagging containing crocidolite), not less than 28 days' written notice must be given to the local District Inspector of Factories.

(b) Where asbestos dust is generated, exhaust ventilation must be provided to prevent its entry into the air of the workplace. Exhaust ventilation equipment must be inspected at least every 7 days and must be thoroughly examined and tested by a competent person at least every 14 months, and a report of such examinations and tests kept available in an approved form for inspection by the Factory Inspectorate for two years.

(c) Where it is impracticable to provide exhaust ventilation in accordance with (b) above, approved respiratory protective equipment and protective clothing must be provided. ('Approved' means approved for the time being by certificate of the Chief Inspector of Factories.)

(d) Workplaces must be kept clean and free from asbestos waste and dust, so far as is practicable. The cleaning should be carried out by a dustless method (again so far as is practicable); where dustless cleaning is not practicable, protective clothing and approved respiratory protective equipment must be provided for persons carrying out cleaning by other methods.

(e) Loose asbestos and asbestos waste must be stored and transported in suitable closed receptacles which prevent the escape of asbestos dust. When they contain crocidolite, such receptacles must be marked with the words 'Blue asbestos – do not inhale dust'.

(f) Suitable changing facilities and storage for protective clothing and respiratory protective equipment (RPE) must be provided, and RPE and protective clothing must be cleaned at suitable intervals. When the cleaning is not carried out at the factory, the protective clothing must be packed in containers which prevent the escape of asbestos dust and which are marked with the words 'Asbestos contaminated clothing'. Accommodation for outdoor clothing must be such as to prevent the deposit of asbestos dust on the clothing.

(g) No one under 18 may be employed in any process or cleaning operation requiring the use of protective equipment.

(h) In new buildings, or buildings where asbestos processes have not been carried out before, certain requirements about cleanliness and cleaning systems must be fufilled before certain specified asbestos processes can begin.

MINES AND QUARRIES ACT 1954

L6 Managers of all mines have a duty under Section 74 of the Mines and Quarries Act 1954, to ensure that the giving off of dust of such character and in such quantity as to be likely to be injurious to the persons employed is minimised, that dust which enters the air is trapped or dispersed harmlessly and that any accumulation of dust is systematically cleared up and removed, or treated to make it safe.

L7 Under Section 112 of the Mines & Quarries Act, quarry managers have a general duty to protect employees against the inhalation of injurious dust. They also have a duty similar to that under Section 74 of the Act.

L8 Clearly both these Sections are primarily concerned with the health risks from dust other than asbestos dust, but in principle they apply to any operation in a mine or quarry where asbestos dust is given off.

AGRICULTURE (SAFETY, HEALTH & WELFARE PROVISIONS) ACT 1956

L9 Dust is not mentioned in this Act or in Regulations under it. We understand, however that Agricultural Safety Inspectors have been issued with advice on how to deal with enquiries on asbestos from the agricultural industry.

OFFICES, SHOPS AND RAILWAY PREMISES ACT 1963

L10 The Offices, Shops and Railway Premises Act promotes safety and health in the workplaces defined in its title. Nothing in the Act or in Regulations made under it lays down duties in respect of asbestos in particular or dust in general (other than general provisions about cleanliness).

HEALTH AND SAFETY AT WORK ETC ACT 1974

L11 The Health and Safety at Work Act and the Regulations so far made under it contain no mention of asbestos or of health risks from dust in general, but the Act does impose general duties on employers, employees, and manufacturers to ensure or help to ensure safe and healthy working conditions. These general requirements apply to health risks from asbestos as well as health risks from any other source. A common feature of many of the general requirements in the Act is that they oblige someone to do something only 'so far as is reasonably practicable'. In interpreting this expression, the Courts have held that a computation must be made in which the quantum of risk is placed in one scale and the sacrifice involved in the measures necessary for averting the risk (whether in money, time or trouble) is placed in the other and that, if it be shown that there is a gross disproportion between them (the risk being insignificant in relation to the sacrifice), the sacrifice need not be made. 'Not reasonably practicable' therefore differs in its strict legal interpretation from 'impracticable' (the term found in, for example, Regulation 8 of the Asbestos Regulations 1969): practicable measures are those which are possible in the light of current knowledge and invention, and measures may be 'practicable' which are not 'reasonably practicable'. Nevertheless the difference in interpretation in everyday use is not so marked.

L12 The general duties in the Health and Safety at Work Act which seem to us to be most relevant to asbestos are summarised below:

(a) Under Section 2 of the HSW Act, employers are required to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all their employees; this is stated to include ensuring, so far as is reasonably practicable, safety and absence of risks to health in connection with the use, handling, storage and transport of articles and substances. This Section has been used by the HSE to enforce standards equivalent to those laid down in the Asbestos Regulations 1969 and Guidance Note EH/10 in some workplaces where the Regulations do not apply.

(b) Section 3 of the HSW Act obliges employers and self-employed persons to conduct their undertakings in such a way as to ensure, so far as is reasonably practicable, that persons not in their employment who may be affected thereby are not thereby exposed to risks to their health or safety. In principle, we are told, this Section could be invoked where there is a health risk to members of the public from work operations involving the use of asbestos.

(c) Section 4 of the HSW Act imposes, inter alia, a duty on any person having control of non-domestic premises who makes them available to persons other than his own employees as a place or work. This Section requires the person having control, to any extent, of the premises to take such measures as it is reasonable for a person in his position to take to ensure, so far as is reasonably practicable, that the premises, means of access or egress, and any plant are safe and without risks to health. Prosecutions have been taken successfully under this Section where persons having control over premises failed to give appropriate information about the known presence of asbestos to contractors whose work on the premises exposed them to risks to their health from the asbestos.

(d) Under Section 5 of the HSW Act, there is a duty to use the best practicable means firstly to prevent the emission into the atmosphere from prescribed premises of noxious or offensive substances and secondly to render such substances as may be emitted harmless and inoffensive.

We have been told that no premises have been prescribed under this Section, however. Air pollution from 'scheduled processes' is currently controlled by the Alkali etc. Works Regulations Acts, but no process involving asbestos is currently scheduled under these Acts.

(e) Section 6 of the HSW Act imposes duties on manufacturers, designers, importers and suppliers of substances for use at work, to ensure generally that these substances are, and remain, safe when put to their intended use. Manufacturers, etc. are also obliged to inform purchasers about any conditions which have to be observed to ensure safety during use, and carry out or sponsor any research necessary for the discovery and (so far as is reasonably practicable) the elimination or minimisation of any health risk to which the substance may give rise.

(f) The general duties of Sections 2, 3, 4 and 6 of the Act have the effect of requiring employers, manufacturers etc to ensure the absence of risks to health so far as is reasonably practicable. It is thus not necessarily sufficient merely to comply with any prescribed standards. The general duties imposed a further obligation to do better than the standards if the necessary steps are reasonably practicable. However, the methods of achieving this objective are not specified. It is open to an employer or manufacturer, for example, to control the risk to health from asbestos by the use of local exhaust ventilation or by substituting a safe or less hazardous alternative material for asbestos. It is up to the employer, manufacturer, etc to choose the method, provided always that it fulfils his obligation under these general duties. In the simple case where substitution provided a demonstrably safe solution at little extra cost, it would be difficult to argue against substitution as the method of complying with the general duties. In practice, however, cases are rarely so clear-cut.

(g) Under Section 15 of the HSW Act, the Secretary of State has power to make regulations supplementing any of the general duties laid down in the Act.

LABELLING

L13 While there is no specific legislation requiring that asbestos products be labelled, there is a requirement under Section 6(4)(c) of the HSW Act which requires that persons who supply substances for use at work shall take steps to ensure that persons handling those substances are given adequate information concerning any known health risks caused by those substances. This could possibly be used to ensure that an asbestos product is labelled. Section 2 of the HSW Act may also be suitable, for S2(2)(b) requires employers to ensure the safe use and handling of substances at work. This might perhaps be interpreted as requiring employers to ensure that their employees know what substances they are handling. However, many asbestos-containing products used in the workplace are already labelled under the voluntary labelling scheme which was described in Appendix H.

SHIPBUILDING

L14 The construction of UK ships, wherever built, is governed by the Construction Rules made under powers in the Merchant Shipping Acts. It is possible that the use of asbestos in such new construction could be controlled in that way, but there are obvious difficulties with existing vessels. The Shipbuilding and Shiprepairing Regulations 1960 are designed to cover safety, health and welfare in ships under construction or repair in harbours, yards, wet or dry docks. Section 76 of these Regulations specifically refers to asbestos and requires breathing apparatus to be used for certain operations.

MEDICAL EXAMINATIONS CARRIED OUT OR ORGANISED BY OFFICIAL BODIES

L15 Section 51 of the Social Security (Industrial Injuries) (Prescribed Diseases) Regulations 1975 lays down that persons engaged in certain specified occupations involving a risk of asbestosis are required from time to time to submit themselves for medical examinations. The specified occupations for the asbestos industry involve the following processes, except where such processes are carried on occasionally only:

(i) breaking, crushing, disintegrating, opening or grinding of asbestos and the mixing or sieving of asbestos, or any admixture of asbestos and all processes involving manipulation of asbestos incidental thereto;

(ii) all processes in the manufacture of asbestos textiles including preparatory and finishing processes;

(iii) the making of mattresses composed wholly or partly of asbestos, and processes incidental thereto.

Occupations for which pneumoconiosis is a prescribed disease (that is occupations in which asbestosis sufferers may be eligible for industrial injury benefit) are given as any occupation involving:

(a) the working or handling of asbestos or any admixture of asbestos;

(b) the manufacture or repair of asbestos textiles or other articles containing or composed of asbestos;

(c) the cleaning of any machinery or plant used in any of the foregoing operations and of any chambers, fixtures and appliances for the collection of asbestos dust;

(d) substantial exposure to the dust arising from any of the foregoing operations.

L16 The Department of Health and Social Security has told us that doctors of the pneumoconiosis medical panels (PMPS) of the Department of Health and Social Security in addition to their main duties relating to claims for industrial injuries benefits undertake the medical examination at their places of work of people engaged in certain processes where there is a pneumoconiosis risk, including those processes listed at (i) – (iii) above where the risk is of asbestosis. These medical examinations take the form of an initial examination within two months of entry into the employment followed by periodical examinations at 2-yearly intervals. The general purpose of the initial examinations is stated to be to identify people with respiratory defects who might, for this reason, be specially liable to contract pneumoconiosis and to advise them against continuing in the employment. The periodical examinations are intended to detect the earliest signs of the disease so that steps can be taken if possible to reduce the risk of it progressing. A person who is found to be suffering from the disease is invited to make a claim for disablement benefit and is given advice as to whether he may safely continue at work and in what dust conditions. His own doctor is told about the diagnosis and, if he gives his permission, his employer is also told. The employer is asked to do his best to safeguard his employee's conditions of work having regard to the panel's advice. The panel can only advise or recommend that a person's employment be changed.

L17 In addition to these PMP examinations a survey is being undertaken by the Employment Medical Advisory Service of the HSE which aims to examine medically all those occupationally exposed to asbestos dust. The survey began in 1970 and, so far as possible, all workers in processes subject to the Asbestos Regulations 1969 are included. The main purposes of the survey are to learn as much as possible, as soon as possible, about the natural history of exposure to asbestos of different types and to varying but measured doses of dust and to provide the evidence of the need for, and ultimately the effectiveness of, dust control measures of all types. At the same time the health of asbestos workers is monitored so that treatment, where necessary, can be given as early as possible. The medical element of the survey consists at present of two-yearly medical examinations and chest X-rays, many of which are carried out on behalf of the EMAS by firms' industrial medical officers. The survey has no statutory basis and workers are free to refuse to be medically examined, but very few have done so.

Appendix M

Calculation of the factors by which short-term samples may exceed those taken over a longer period

In the estimation of the factors by which short-term samples may exceed those taken over a longer period, it is assumed that the distribution of the samples taken at a given workplace is log-normal, and that a suitable measure of their variability is therefore the geometric standard deviation. It is also assumed that the geometric standard deviation of short-term samples (that is, those of a shift or less) will not be less than 1.5. By calculation, we can derive the following table:

Relationship between a control limit (CL) applied to single sample results and the long-term average of the log-normally distributed samples

Proportion of samples complying with control limits			
Geometric standard deviation of the distribution of individual samples	*Long-term average concentrations*		
	95%	99%	99.9%
1.5	CL/1.80[a]	CL/2.37	CL/3.22
2.0	CL/2.47	CL/3.95	CL/6.70
3.0	CL/3.35	CL/7.07	CL/16.30
4.0	CL/3.77	CL/9.67[b]	CL/27.74

The approximate factors 2 and 10 suggested in para 171 of Chapter 4 correspond to a typical range of standard deviation (1.5 to 4.0) and of compliance (95% to 99%) (a) and (b) in the table.

Appendix N

Employers' estimates of the likely impact of reducing the control limit for exposure to dust from chrysotile asbestos to 1 fibre/ml.

N1 Table N1 shows employers' estimate of the impact of a 1 fibre/ml control limit in terms of increases in costs and prices of various products and Table N2 in terms of sales and employment. Table N3 permits some comparisons with the home market sales of products produced by the asbestos industry.

ASBESTOS CEMENT PRODUCTS

N2 For a discussion of employers' estimates of the likely impact of reducing the control limit for exposure to dust from chrysotile asbestos to 1 fibre/ml in the manufacture and use of asbestos cement products, see paragraphs 182–190.

FLOOR TILES AND OTHER FLOOR COVERINGS

N3 In the manufacture and installation of floor tiles containing asbestos and asbestos-backed cushion flooring only short chrysotile fibres are used and the asbestos content of both types can be up to 20% of the total weight. Dust counts for both types appear to be normally below 1 fibre/ml so that such a control limit should necessitate little if extra capital equipment, merely improved housekeeping. The cutting of floor products to shape during floor laying is similar to the cutting process carried out during manufacture. Readings taken during laying have been typically below 0.2 fibres/ml over 4 hours even with cushion flooring where asbestos is in its most exposed form. Only a small amount of dust is generated in the cutting of vinyl tiles and analysis has shown this to be nearly all limestone rather than asbestos.

N4 However, it must be recognised that any floor covering will probably be replaced and it is this operation which can lead to the release of considerable amounts of fibre, especially with cushion flooring. Hand scraping of tiles commonly produces dust levels of over 1 fibre/ml and sanding gives very high dust levels. Thus enforcement of a rigid compliance with a 1 fibre/ml standard will mean that asbestos using products could no longer be used on certain types of flooring. The necessary modifications to plant and materials to achieve a 1 fibre/ml standard would probably add about 5% (£4 million) to the cost and hence probably also to the price of tiles and other plastic flooring.

N5 There has been a trend towards an asbestos-free backing material for sheet vinyl tiles and some firms already make all their tiles without the use of asbestos. We are advised that to move completely on to asbestos free products could increase the costs of thermoplastic tiles by between 25 and 50 per cent and this would be felt most strongly by the major users of the tiles in the public and private housing sectors of the market. We also understand that asbestos has a major function as a processing aid as well as a component and its elimination could therefore result in slower production speeds which in turn could reduce capacity and further raise costs. We have been told that companies thus affected would be unlikely to expand their facilities to compensate for this increase in costs and the most likely outcome could therefore be an increase in imports.

FRICTION MATERIALS

N6 In friction material manufacture the technology is available to reduce dust levels to 1 fibre/ml at a capital cost of about £5 000 000, additional running costs of approximately £2 000 000 a year and a further cost in reduced productivity of roughly £2.5 million. If the capital cost were spread over a number of years, the total cost would put up the price of finished goods by about 12 per cent. Assuming that brake linings, etc., are sealed before delivery, manufacturers of original equipment should have no difficulty in meeting a TWA limit of 1 fibre/ml using existing equipment in drilling and grinding. Similarly this level could be met in garages carrying out replacement of brake and clutch linings but there may be difficulties in enforcing the necessary work practices. It is estimated that imports would grow, probably capturing an additional quarter of the replacement market.

JOINTINGS, PACKINGS AND GASKETS

N7 Jointings, packings and gaskets constitute a very mixed category. Dust levels are in general low during manufacture but frequently average over 1 fibre/ml in

Table N1 Impact on asbestos industry of 1 fibre/ml limit: increases in costs and prices§

	Capital £m	*Current £m p.a.*	*Price %*
Asbestos cement	0.5	0.3	1½
Insulation materials	*	*	4*
Friction materials	5.0	4.5	12½†
Gaskets, jointings and packings	0.7	0.4	+ 3½†
Other asbestos textiles millboard and paper	10.0‡	3.3	+17
Flooring	2.5	1.5	5
Paints, adhesives, etc	...	...	...
Reinforced plastics	...	...	...
Total	18.7	10.0	

Source: Asbestos Information Centre.
§ As compared with 1976.
* Would not be incurred because consumers could not comply with standard.
† Including addition to costs of bought in textiles.
‡ Assuming technically feasible.

Table N2 Impact on asbestos industry of 1 fibre/ml limit: sales and employment*

	Exports £m	*Imports £m*	*Home market %*	*Production %*	*Employment thousands*
Asbestos cement	− 0.5	...	−10½	−11½	−0.7
Insulation materials	− 3.0	...	−100	−100	−1.0
Friction materials	− 6.0	+14.0	...	−30	−2.7
Gaskets for motor vehicles	...	...	...	...	−0.5
Other jointings and packings	...	...	...	...	
Other asbestos textiles millboard and paper	− 2.0	+ 1.5	...	− 9	
Flooring	− 2.5	+ 0.5	...	− 4	−0.6
Paints, adhesives, etc	...	...	...	...	...
Reinforced plastics	...	...	...	...	...
Total	−14.0	+16.0			−5.5

Source: Asbestos Information Centre.
* Assuming no change in standard for/availability of/asbestos products from abroad, and based on 1976 prices.

processing millboard and where yarn is being braided dry. We understand that the annual cost increase of meeting a 1 fibre/ml limit everywhere would range, according to the circumstances, between a negligible percentage of present costs to 3 per cent. In addition to a 17 per cent increase in the cost of textiles already mentioned which might add 1½ per cent to the cost of producing jointings and packings containing them. No difficulties are anticipated in meeting a 1 fibre/ml limit in user applications.

TEXTILES

N8 In textile manufacturing, the industry tells us that it may be technically feasible to reduce long term average concentrations to below 1 fibre/ml by employing more extraction plants and by fully enclosing carding machines, but they are not prepared to guarantee success. Increased capital and running costs of such a limit would put up the price of the products by an estimated 17 per cent on average. Where dust suppressed textiles are used dust concentrations are already below 1 fibre/ml but extra ventilation or extraction would be required to comply with this limit if non-dust suppressed textiles continued to be used.

OTHER PRODUCTS

N9 In the manufacture and use of asbestos-reinforced plastics, dust levels appear already to be generally below 1 fibre/ml so no extra cost would be incurred, while in the manufacture and use of adhesives, underseals and similar products containing asbestos a marginal improvement in housekeeping is all that would be necessary to ensure that operations were within a 1 fibre/ml limit.

Table N 3

Home market sales of asbestos industry products in 1976	*£m*
Asbestos cement	47
Friction materials	56
Jointings, gaskets and packings	54
Insulation materials and all others	20
	177
Exports	42
Total	219

Industrial end-use of asbestos products in 1976	*£m*
Metals and engineering	19
Motor vehicles	83
Shipbuilding and other vehicles	7
Construction	63
Public utilities and all others	5
Total	177

Source: Asbestos Information Centre.

The General Public

241 Although there is no quantitative evidence of a risk to the general public from exposure to asbestos dust, there has been increasing interest in the relationship between the use of asbestos at work and the effects which this might have on people not directly involved but in the vicinity of work with asbestos or who may use or come into contact with the goods, facilities or services produced. Controls do exist already for some of these points of contact, and these are summarised in Table 25 and described more fully in Appendix P. We discuss here whether any changes are desirable in the light of their examination.

Emissions from the workplace

242 We have found that there is little specific control over the emission of asbestos dust into the atmosphere. Bearing in mind the importance of curbing environmental pollution, we believe that steps should be taken to reduce these emissions.

243 It should be possible to define a class of asbestos works which can be scheduled under the Alkali Act or under Section 5(1) of the Health and Safety at Work etc Act, and proposals have already been put forward by the HSE to the Health and Safety Commission. We have been told that scheduling would enable the appropriate inspectorate to require and inspect air cleaning arrangements, the dust creating processes themselves and maintenance arrangements and to set a limit on the permitted emissions. We understand that the control of emissions from non-scheduled asbestos premises would be much more difficult and it is likely that general requirements for ventilating plant and filtration in specified situations would be better than attempts to set any quantified emission standards. However, where there is evidence of a health hazard in these situations, duties under S.3 of the HSW Act can be invoked.

Recommendation 32: we recommend that asbestos dust emissions from workplaces should be subject to more specific control and that special attention should be given to the possibility of scheduling a class of asbestos works under appropriate legislation.

244 In order more effectively to identify and control emissions into the atmosphere, there needs to be better information than is presently available on the need for and performance of control measures. This could be compiled most effectively at the workplaces themselves to inform employers, workers and other interested parties and be available to the HSE to allow all concerned to better assess the operation of measures used to control emissions.

245 This proposal would be appropriate for the scheduled processes discussed in para 243 above and possibly for some other operations in specified circumstances. We believe, however, that it could not be applied generally. Clearly, any such new requirement on measuring would need to be designed so as to be compatible with local authorities' powers under the Control of Pollution Act. The appropriate Inspectorate in liaison with other parties in HSE and after consultations with the industry, could help in the provision of guidance on the best practicable means of taking and assessing the samples.

Recommendation 33: we recommend that if recommendation 32 is implemented, designated and especially scheduled works which emit asbestos dust into the atmosphere should measure such emissions regularly and systematically and keep appropriate records.

Asbestos in the general atmosphere

246 On the basis of the evidence currently available, we concluded in Chapter 3 that, unless contaminated buildings are very much commoner than seems likely, no appreciable mortality from lung cancer can be associated with any degree of contamination by chrysotile likely to be encountered in the UK in the air or in buildings not under active construction or repair. Even so, we recommend in our second report that a programme of work should be prepared to evaluate asbestos exposure in the non-occupational environment. We advised that resources would be most usefully directed initially to places where contamination with asbestos dust was likely to be highest and where information was most quickly needed. We are glad to hear that the Department

Table 25 Current legal and administrative controls for the general public

Relevant legislation etc	*General remarks*	*Summary of the relevant provisions*
Public Health Act 1936 and 1961	Statutory nuisance provisions of Act may apply	1 Local Authorities (LA's) responsible for the control of asbestos emissions. 2 Use of asbestos in the construction of buildings is covered by the Building Regs 1976 made under the Public Health Acts. These Regs apply in whole of England and Wales except inner London where the London Building (Constructional) Bye Laws apply. Similar Regs apply in Scotland and Northern Ireland.
Public Health (Scotland) Act 1897	S16 (General nuisances)	LA's have a responsibility for (1) any accumulation or deposit of mineral refuse which is noxious, or injurious, or dangerous to health; (2) any work etc injurious to the health of the neighbourhood or so conducted as to be injurious or dangerous to health; (3) LA's have a duty to inspect their area from time to time to identify nuisances.
Clean Air Acts 1956 and 1968	Emissions of dust from furnaces covered	Any asbestos in dust from a furnace can be subject to some element of dust control.
Control of Pollution Act 1974	Act provides framework for a systematic and co-ordinated approach to waste collection and disposal	1 LA's have powers to require information from any works about emissions to air at intervals of 3 months or more. 2 A waste disposal site licensing regime now operates.
Merchant Shipping (Dangerous Goods) Rules 1965	The carriage of dangerous goods and substances as cargo on UK registered ships is regulated and controlled under these rules	Specific advice on carriage and packing of individual substances is given in the International Maritime Dangerous Goods Code.
Merchant Shipping Act 1970	Powers are available under S19 to make regulations to secure safe working conditions and practices	1 The Dept of Trade's recommendation made in the 'Code of Safe Working practices for the Safety of Merchant Seamen'. 2 The Department of Trade have issued Merchant Shipping Notices on asbestos.
Deposit of Poisonous Waste Act 1972		1 Disposers of most types of asbestos waste should notify the responsible authority. 2 It is an offence to deposit poisonous noxious or polluting waste on land in such a way that it is liable to give rise to an environmental hazard.
Rivers Prevention of Pollution Acts 1951 and 1961	There is a similar Act in Scotland	Any discharge of liquid effluence to controlled waters from asbestos works requires the consent of the relevant Water Authority in England or Wales or River Purification Board in Scotland.
Consumer Safety Act 1978		There is no legislation dealing specifically with the use of asbestos in consumer products but there is power to introduce such legislation in the Act.
Food Drugs Act 1955 England and Wales		There are similar Acts in Scotland and Northern Ireland; while there are no specific statutory limits laid down in UK for the levels of asbestos in food, this Act will apply to any question of contamination.
Water Act 1973		Water Authorities supply water and LA's should see the water is wholesome.
Health & Safety at Work etc Act 1974		S3 obliges employers and self-employed persons to conduct their undertakings in such a way as to ensure, so far as is reasonably practicable, that persons not in their employment who may be affected thereby are not thereby exposed to risks to their safety.

of the Environment and the HSE are already organising a monitoring programme on these lines.

Recommendation 34: we recommend that when the Government's monitoring programme on asbestos in air is complete the data be assessed by the appropriate public bodies in the light of the medical evidence to determine whether any further action is needed. Until then, it would be premature for us to make any further recommendations.

Asbestos in buildings

247 Two suggestions have been made to us in this field – (a) that in specified circumstances, persons in control of premises, articles, structures or plant should be required to furnish available information on their asbestos content to contractors engaged for their repair, demolition or removal, and (b) that all building plans should indicate where asbestos-bearing materials have been specified for use in the construction of a building. However, we believe that both measures would tend to weaken the obligation on contractors to safeguard their own employees and that the second measure would be ineffective and could create a false sense of security since Building Regulations do not apply to all buildings and there is no requirement to build exactly in accordance with the plans deposited.

248 Our evidence of the non-occupational risk is not such as to prompt us to recommend the general removal of asbestos from existing buildings. Present evidence (see Appendix E) suggests that dangers from asbestos in buildings are likely to arise only when asbestos fibres are released into the air when products containing asbestos are damaged, either accidentally or during maintenance or repair. For maintenance and repair, legislation already exists to minimise risk and we do not believe that accidental damage is a situation that is appropriate for legislation. It is more a matter for education and information (by, for example, a codification of good practice) to ensure that accidental damage is dealt with promptly.

Transport of asbestos

249 There seems little doubt from the evidence that we have seen that the use of freight containers for the importation of raw asbestos which itself is packed in sacks enclosed in a wrapping should eliminate handling of the bags and thus virtually eliminate the risk to dockers from exposure to raw fibre. The risk remains at present that the hold of a ship may be contaminated with asbestos dust from earlier cargoes which were not containerised and this reinforces our view that there are obvious gains to be obtained by containerisation.

Recommendation 35: we recommend that a new legal obligation should be introduced so that from 1 December 1980 no raw asbestos may be imported into the UK unless it is shipped in totally enclosed metal-clad non-ventilated ISO general purpose freight containers.

250 It is clearly desirable that the raw fibre should remain in its container until it has reached the factory where it is to be used for the manufacturing process so that the possibility of spillage due to accidents is minimised. This should not be difficult where a complete container load is going to one factory but this is not always the case. This question needs further attention but meanwhile we believe that further precautionary measures should be taken.

Recommendation 36: we recommend that raw asbestos fibre and other loads liable to give rise to asbestos dust should be transported only in such a way as to prevent the escape of any such dust.

251 Care should also be taken not to use for other purposes receptacles that have been used to transport raw asbestos fibre or products liable to give rise to asbestos dust. Where such re-use is considered necessary, it should take place only after effective cleaning, applying the controls and precautions recommended in Chapter 4.

252 We understand that proposals for across-the-board regulations on the conveyance of dangerous substances by road are being prepared by the Health and Safety Executive. We suggest that our proposals could be enacted by making asbestos subject to the relevant parts of these regulations.

Waste disposal

253 We have been advised that the powers of waste disposal authorities are already adequate to deal with waste tips currently in use, but we believe that they could usefully be extended to control problems arising from disused tips containing asbestos.

Recommendation 37: we recommend that waste disposal authorities should have powers (similar to those under Section 16 of the Control of Pollution Act 1974) to identify a disused tip where asbestos is thought to be a hazard, to carry out the necessary works to render it safe and to recoup the expense from the occupier or depositer wherever possible.

254 This would enable investigations to be made in situations such as, for example, receipt of an application for planning permission to build on land believed to have been used for disposal of industrial waste materials which might include asbestos. Action following our recommendation at this stage would help to avoid future uncertainties and possible risks to health once building work has begun.

Controls on sale of consumer products

255 Any moves towards the substitution of other materials for asbestos under the framework we have suggested in paras 146 to 158 will naturally affect the extent to which asbestos is used in consumer products.

But some consumer products are likely to contain asbestos for the foreseeable future, so that application of consumer protection legislation needs to be considered. Until there is more information from, for example, public environmental measurements on the dust levels associated with the use of consumer products, we believe that it would not be appropriate to introduce control limits for them as we have recommended should be introduced or revised in the manufacture and use of other products containing asbestos. However, the present limitation on, and difficulties in adding to, the results from measurements of exposure to asbestos dust from consumer products makes all the more important a careful examination of the use of asbestos in their manufacture and the study of suitable substitutes.

256 We are concerned about any use of asbestos in consumer products without adequate justification and we believe that some action to prevent the unjustifiable use of asbestos may be needed. This action could be taken under the existing powers to make regulations enforceable at the point of sale, relating to the composition, labelling, etc of consumer products, where that is appropriate to prevent risk of injury to health.

257 Although many factors can be used in its practical assessment, it is very difficult to define an 'unjustifiable' use of asbestos accurately enough to make any general ban workable. An alternative would be to set up a scheme whereby the incorporation of asbestos in any consumer product had to receive prior approval. But this would involve considerable expenditure of resources and we think that there should be firmer evidence of the degree of hazard that exists from asbestos in consumer products before such an elaborate mechanism is introduced. The (then) Department of Prices and Consumer Protection have told us that the same result (the prevention of unnecessary uses of asbestos) can be achieved by administrative means – through investigation of individual cases and agreements with manufacturers – backed up by resort to regulations on specific products, if this proves necessary.

258 If the trend away from the use of asbestos in the manufacture of consumer goods continues, reinforced by the recommendations made in the previous chapter, there will be a progressive reduction in the range and number of products on retail sale which could possibly entail risks to health. For the products which remain on sale – particularly D-I-Y goods which can be used in employment as well as by consumers – we believe that the consumer should know clearly when asbestos is present.

259 At the moment the consumer can only tell that a product contains asbestos if it is labelled under the voluntary labelling scheme being encouraged by the (then) Department of Prices and Consumer Protection (see Appendix H). At present it appears that the labelling scheme is being increasingly accepted but that the proportion of consumer goods covered by it cannot yet be regarded as satisfactory. A great deal of publicity has been given to the scheme in the trade press and work is being undertaken to identify problem areas. We believe that there is only a small risk to individual consumers from the presence of asbestos in the products they buy and use and the degree of risk clearly varies from product to product. However, as asbestos is found in a wide range of products which are used by many people, we feel strongly that, in the interests of freedom of choice, the public should be able to know from appropriate labelling when asbestos is present.

Recommendation 38: we recommend that if experience shows that voluntary compliance with the present labelling scheme for consumer products containing asbestos is inadequate, it should be made obligatory by appropriate regulations.

Food and drink

260 We endorse the conclusion of the Food Additives and Contaminants Committee (see Appendix J) that it would be prudent to ensure that asbestos fibre contamination of drinking water, beverages and food is reduced to a minimum and recommend that all possible action should be taken to achieve this. In the light of the FACC report, we support their view that it is not appropriate to recommend the introduction of statutory controls of asbestos in materials and articles in contact with food nor in food itself and share their view that existing legislation gives enforcement authorities sufficient powers to take action to safeguard consumers against risk to health from the ingestion of asbestos fibres and to give Ministers powers to introduce controls if needed.

261 We note the FACC's recommendations concerning the possibility of food contamination from, for example, building materials and spillage in transit. Having looked at these same problems from the point of view of protecting those directly exposed to asbestos dust from such sources, we accept the need also to safeguard against indirect exposure through the contamination of food supplies.

262 We understand that a pilot study has been carried out by the Water Research Centre on the levels of asbestos currently found in UK drinking water, taking into account so far as possible the hardness and softness of the water itself and the effects of natural asbestos strata, passage through asbestos cement pipes, storage in asbestos cement cisterns and percolation from waste disposal sites. A larger scale survey by the Department of the Environment is planned. Until the results of this research are available, as well as appropriate medical evidence, we feel unable to make any recommendation on the control of asbestos in drinking water.

263 The FACC asked to be kept informed of the progress of studies in the UK and elsewhere of the effect of the ingestion of asbestos and will reconsider

its recommendations in the light of any new information. Although the evidence currently available suggests that the risks to health from the contamination of food and drink with asbestos are mimimal, we believe that this should be reviewed regularly.

Recommendation 39: we recommend that there should be a regular review of information concerning the risks to health from the contamination of food and drink by asbestos.

Information

264 We have mentioned on different occasions that in our view more information and guidance is required on certain topics. We are also aware that in many cases information would be better known and used if the relevant details could be combined in one place and suitably summarised.

Recommendation 40: we recommend that all the existing requirements, regulations, codes of practice and guidance notes relating to asbestos should be brought together in one publication.

265 We do, however, believe that there is scope for increasing the amount of information available where, eg, its dissemination is restricted by legislation.

Recommendation 41: we recommend that relevant legislation should be examined with a view to reducing the statutory limitations on the disclosure of information relating to asbestos.

266 This, with our own reports and any future material based upon them, would, we hope, give employers, employees and the general public easier access to all the relevant information which presently exists.

Appendix P

Present legal and administrative controls for the general public

P1 This Appendix examines existing controls on asbestos outside the workplace where the general public may be directly or indirectly in contact with asbestos. It begins by examining operations connected with the workplace and then looks at other areas with which the public – including, of course, workers themselves – are concerned. Information in the Appendix has been provided by the relevant inspectorates and government departments. It is arranged by subject rather than by legal jurisdiction (as in Appendix L) as we believe that this presentation will be more helpful to the reader in view of the more diverse areas covered.

EMISSIONS FROM WORKPLACES

P2 We understand that emissions of asbestos to the wider environment are not controlled specifically by legislation or statutory approved codes of practice although Section 3 of the HSW Act is relevant. If an emission should cause a rsik to health, then there is an obligation under Section 3 to remove that risk so far as is reasonably practicable.

P3 At present, control of asbestos emissions is the responsibility of local authorities under the statutory nuisance provisions of the Public Health Act 1936. In the Public Health (Scotland) Act 1897, Section 16 (General Nuisances) is implicitly relevant to asbestos, especially Section 16(5), which related to any accumulation or deposit of mineral refuse which is noxious or injurious or dangerous to health, and Section 16(6), which relates to any work etc, injurious to the health of the neighbourhood or so conducted as to be injurious or dangerous to health. Local authorities (District Councils and Island Councils) have a duty to inspect their area from time to time to identify nuisances.

P4 The Clean Air Acts 1956 and 1968 control emissions of dust from furnaces. Any asbestos in dust from a furnace could thus conceivably be subject to some element of general dust control.

P5 Local authorities already have power, under the Control of Pollution Act, to require information from any works about emissions to air, at intervals of three months or more. This in effect requires employers in receipt of such requests to monitor emissions, although an employer can appeal against supplying the information, for example, on grounds of cost. Under some circumstances the local authority can carry out the tests themselves. We do not, however, know of any instances of local authorities exercising their power to require employers to monitor asbestos dust emissions.

ASBESTOS IN BUILDINGS

P6 The Department of the Environment have told us that the use of asbestos in the construction of buildings is covered by the Building Regulations 1976 made under the Public Health Acts of 1936 and 1961 as amended by Part 3 of HSW Act. These regulations apply in the whole of England and Wales except inner London, where the London Building (Constructional) Byelaws apply. Similar regulations apply in Scotland (the Building Standards (Scotland) Regulations 1971–1975) and in Northern Ireland.

P7 The Building Regulations do not either require or prohibit the use of asbestos in buildings; in the main they specify standards for the construction of buildings which, in certain specified circumstances, may be deemed to be satisfied by the use of asbestos materials. Responsibility for the day-to-day administration of the regulations rests with local authorities in the first instance and they have powers to relax or dispense with a number of provisions as they think fit.

TRANSPORT

P8 We do not know of any controls or legislation dealing specifically with the transport of asbestos on land. Some guidance is given on the transport of asbestos waste by the Asbestosis Research Council, and British Rail's Working Manual for Rail Staff stipulates that loose asbestos or asbestos waste must be packed in such a way as to prevent spillage or escape of dust.

P9 We have been told that the provisions of the Asbestos Regulations 1969 would generally apply to ships only in respect of work carried out in a UK harbour or wet dock.

P10 The carriage of dangerous goods and substances as cargo on UK-registered ships is regulated and controlled under the Merchant Shipping (Dangerous Goods) Rules 1965. Specific advice on the carriage and packing of individual substances is given in the International Maritime Dangerous Goods Code published by the Inter-governmental Maritime Consultative Organisation of the United Nations, which is applicable to ships under the flags of member states, including ships registered in the UK. The International Code now covers the carriage of all kinds of asbestos. This advice is supplemented by the Department of Trade's Code of Practice on 'Carriage of Dangerous Goods in Ships', commonly known as the 'Blue Book', which has special provisions relating to crocidolite.

P11 Powers are available under Section 19 of the Merchant Shipping Act 1970 to make regulations to secure safe working conditions and practices including, more specifically, requiring, prohibiting or regulating the use of any material or process. Any such regulations would apply to all ships registered in the United Kingdom, wherever they might be operating.

P12 The Department of Trade's recommendations 'Code of Safe Working Practices for the Safety of Merchant Seamen' first published in 1970 do not specifically refer to asbestos but seamen are advised to wear protective clothing and equipment including respiratory equipment, when handling dangerous substances or when exposed to dangerous or irritating concentrations of dust and fumes. A revised edition of this Code was published in 1978 and included specific advice on the precautions to be taken when handling or working with asbestos products.

P13 Merchant Shipping Notices ('M' Notices) are issued by the Department of Trade from time to time to the shipping industry to disseminate information on particular hazards which have come to attention from accidents on or casualties to ships and give urgent guidance on measures for avoidance. Such a Notice has recently been issued on the subject of asbestos, giving guidance on its potential dangers, where it is likely to be found on board ship and the precautions to be taken when working in circumstances where dust could be created.

WASTE DISPOSAL

P14 This subject is the concern of the Department of the Environment (DOE) (and the Scottish Development Department in Scotland) who have provided the information in the following paragraphs.

P15 The first major step towards controlling the disposal of asbestos waste was made in 1969, when the Asbestosis Research Council produced a 'Recommended Code of Practice for the Handling and Disposal of Asbestos Waste Materials'. The Department of the Environment was involved in drafting the code of practice, and endorses its use by the industry. The code was revised in March 1973. The aim of the code of practice is to advise the asbestos industry and the waste disposal industry on how best to comply with the relevant requirements of the Asbestos Regulations 1969, and the best method of disposal of waste asbestos, in order to eliminate, as far as possible, any risk to the general public. It advises, for example, bagging of all asbestos waste, separate marking of bags containing crocidolite asbestos, and prompt covering of the bags after disposal. The code of practice also gives guidance on action to be taken in the case of spillage of waste asbestos following an accident involving the vehicle in which it is being transported.

P16 Legislation followed, with the Deposit of Poisonous Waste Act 1972. Under this Act, disposers of certain wastes, including most types of asbestos waste, are obliged to notify the responsible authorities of the removal and deposit of such waste, giving details of the type and quantity of waste involved. It is an offence under this Act to deposit poisonous, noxious or polluting waste on land in such a way that it is liable to give rise to an environmental hazard.

P17 The Control of Pollution Act 1974 provided the statutory framework for a systematic and co-ordinated approach to waste collection and disposal in order to ensure that disposal is carried out to satisfactory standards. Under Sections 3–11 a site licensing regime has been created under which anybody wishing to operate a disposal site or treatment plant has to obtain a site licence from the waste disposal authority (the County Councils in England and District Councils in Scotland and Wales). The waste disposal authorities are empowered to impose operating conditions on the sites; they have extensive supervisory and enforcement powers to ensure that sites are run satisfactorily and that operating conditions are met. They are required to maintain similarly high standards at sites which they themselves operate. Statutory consultees, who must be approached before a licence is granted, include the water authority, the collection authority and the Health and Safety Executive. Disposal of waste subject to the licensing system except in accordance with the terms of a valid licence is an offence.

P18 The 1974 Act also provided for a more intensive control system for certain especially hazardous or difficult wastes. These wastes have yet to be defined but are likely to include many forms of asbestos waste. Under the licensing system described above sites receiving such 'special wastes' (including asbestos) are subject to appropriate operating conditions; in addition it is intended to impose controls on the producers of special wastes, by means of regulations under Section 17 of the Act, to ensure that the wastes can be followed through from the point of origin to final disposal. Section 17 regulations are intended to replace the provisions of the Deposit of Poisonous Waste Act 1972 which will then be repealed.

P19 Department of the Environment technical groups, on which the manufacturing and waste disposal industries are represented, are producing a series of Waste Management Papers. These are technical memoranda on arisings, treatment and disposal of particular wastes. They include a recommended code of practice. A Waste Management Paper on asbestos wastes was published in May 1979.

P20 Under the Rivers (Prevention of Pollution) Acts 1951 and 1961, and the Rivers (Prevention of Pollution) (Scotland) Acts 1951 and 1965, any discharge of liquid effluent to controlled waters from industrial premises (including asbestos works) requires a consent from the relevant Water Authority in England or Wales, or the River Purification Board in Scotland. Controlled waters are – broadly – all rivers and other inland waters and a number of estuarial and coastal waters, including in particular all the major estuaries. (When Part II of the Control of Pollution Act 1974 is brought into force by Commencement Order, controlled waters will extend to all coastal waters around Britain, generally to the 3 mile limit.)

CONSUMER PRODUCTS

P21 We understand that there is, at present, no legislation dealing specifically with the use of asbestos in consumer products. The power to introduce such legislation does, however, exist under the Consumer Safety Act 1978. Under the Act, the Secretary of State may make regulations relating, inter alia, to the contents and labelling of any class of products where he considers this appropriate to ensure the safety of goods or the provision of appropriate information.

P22 The present policy of the Department of Prices and Consumer Protection (DPCP) is to rely on voluntary co-operation from the industry. This has resulted in the voluntary labelling scheme under which consumer products containing asbestos will carry a cautionary label (see Appendex H). Leaflets on the safe use of asbestos products are also available for distribution at retail outlets. In the normal course of DPCP's work, agreements may also be made with manufacturers to cease using asbestos in the particular product, where such actions seems justified.

FOOD AND DRINK

P23 The agriculture and health departments in England and Wales and the health departments in Scotland and Northern Ireland are responsible for legislation in this field which is enforced by local authorities. While there are no specific statutory limits laid down in the United Kingdom for the levels of asbestos in food, the general provisions of the Food and Drugs Acts will apply to any question of contamination. The primary food and drugs legislation is contained in:

The Food & Drugs Act 1955 – England and Wales
The Food & Drugs Act (Scotland) 1956 and
The Food & Drugs Act (Northern Ireland) 1958.

P24 The provisions which are relevant (the Section numbers are the same for each of the Acts) are Sections 1(1), 2(1), 8(1) and 8(2), which prohibit the preparing of food so as to render it injurious to health and the sale of food which is not of the nature, substance or quality demanded by the purchaser or is otherwise unfit for human consumption. Section 9 gives power for the seizure and destruction of food which is unfit for human consumption.

P25 Section 13(2)(c) gives Ministers powers for securing the observance of 'sanitary and cleanly conditions or otherwise' for the protection of the public health, to make regulations to prohibit or regulate 'the use of any specified materials of any specified class, in the manufacture of apparatus or utensils designed for use in the preparation of food for human consumption, and the sale or importation for sale of apparatus or utensils designed for such use and containing any specified materials, or materials of any specified class'. Under this provision, we understand, it would be possible to prohibit or regulate the use of such things as filter pads, or kitchen equipment containing asbestos, which were designed for use in the preparation of food for human consumption.

P26 We have been told that although these two provisions may appear to overlap, there is a clear distinction between them. Regulations under Section 4(1)(b) of the Act would be directed to processes or treatments (eg pasteurisation or freezing) but those under Section 13(2)(c) would be directed to materials used in the manufacture of apparatus intended for use in the preparation (including manufacture) of food. Neither section could be used where the contact was with water, which is specifically excluded from the Act, or where any contamination was merely a consequence of packaging or containing as opposed to preparing food.

P27 Regulations so far made under the Acts with a bearing (albeit indirect) on asbestos are those controlling the use in food of talc, which may contain asbestos as an impurity. These are the Miscellaneous Additives in Food Regulations 1974, and the equivalent regulations in Scotland and Northern Ireland which require that asbestos should not be present in food grade talc when subjected to a microscopic test.

P28 One of the provisions of Directive 76/893, adopted by the EEC Council of Ministers in November 1976, is that materials and articles intended to come into contact with foodstuffs must be manufactured in compliance with good manufacturing practice so that, under their normal or foreseeable condition of use, they do not transfer their constituents to foodstuffs in quantities which could: endanger human health; or bring about an unacceptable change in the composition of the foodstuffs or a deterioration in the organoleptic characteristics thereof. The Materials and Articles in Contact with Food Regulations 1978 (SI 1978 No. 1927) made under the provisions of the European Communities Act 1972 will implement this Directive in UK law from 26 November 1979.

DRINKING WATER

P29 Two requirements of the Water Act 1973 are for water authorities to supply water (Section 11(1)), and for local authorities to take such steps as are necessary to ascertain that the supply is wholesome (Section 11(2)). It would be for the local authority to declare that the water received by a consumer was not wholesome because of the presence of asbestos. There are no national criteria for water and a limit for asbestos fibre content would be decided upon subjectively.

P30 In addition, the Model Water Byelaws (1966 edition) do not allow materials to come into contact with water if those materials are likely to contaminate water significantly or lead to its waste. Should it become necessary (that is, if a significant health hazard should be discovered) asbestos cement pipes and tanks could be prohibited. These Model Byelaws are being revised and it is probable that materials not in contact with water but likely to contaminate it (eg covers to water tanks) will be included in the future editions.

Summary of recommendations

5

New proposals for legal and administrative controls in the workplace

Recommendation 1: we recommend that there should be a statutory ban on the import of raw crocidolite fibre to prevent its reintroduction into the UK and that this should be extended to the import of products containing it providing the practical difficulties can be overcome. (para 143)

Recommendation 2: we recommend that the term 'containing crocidolite' should be defined and that the definition should specify the technique or techniques of analysis to be used and the criteria for deciding whether crocidolite is present. (para 144)

Recommendation 3: we recommend that, if as at present an employer chooses to treat a given substance as containing crocidolite, he should continue to be under no obligation to carry out tests to determine whether crocidolite is in fact present. (para 145)

Recommendation 4: we recommend that, if an employer does not treat a substance as containing crocidolite, the onus should be on him to show that crocidolite is not present if his action is challenged. (para 145)

Recommendation 5: we recommend that an explicit obligation should be placed on any person who produces specifications for or carries on a process involving the use of asbestos or any product containing it to consider the substitution of asbestos by other materials so far as it is reasonably practicable to do so. When doing this he should weigh the relative advantages of asbestos and potential substitutes, taking into account current knowledge about potential health risks, suitability in the production and performance of the finished product and costs associated with the change. (para 153)

Recommendation 6: we recommend that the Health and Safety Executive, or the Health and Safety Commission as advised by its Advisory Committee on Toxic Substances, should provide and publish both advice on the general principles involved in conducting the evaluation and data on particular possible substitutes so that employers can better fulfil their obligations as proposed in Recommendation 5 above. (para 154)

Recommendation 7: we recommend that the Health and Safety Executive or the Health and Safety Commission, when framing its advice and future policy on substitutes for asbestos, should take into account the social costs of obtaining, using and disposing of asbestos as well as the costs and benefits which can be more easily identified and forecast. (para 157)

Recommendation 8: we recommend that the term 'hygiene standard' should be replaced by 'control limit' for the assessment of exposure to asbestos dust. (para 161)

Recommendation 9: we recommend that a single control limit for each type of asbestos should be applied to all processes involving asbestos or products containing it, and that this set of limits should have legal backing. (para 165)

Recommendation 10: we recommend that legislation should be prepared making clear that an overriding requirement to reduce exposure to asbestos dust to the minimum that is reasonably practicable should be applied in conjunction with Recommendation 9. (para 166)

Recommendation 11: we recommend that for the purposes of assessing compliance with control limits, industry, enforcing authorities and others should use personal sampling employing the membrane filter method. (para 168)

Recommendation 12: we recommend that the control limit for each type of asbestos could most reasonably be applied to the result of measurements taken during a 4 hour sampling period. (para 172)

Recommendation 13: we recommend that where it is not reasonably practicable or appropriate to collect information covering the whole 4 hour sampling period, the shorter sample decided upon should be treated as representative of the longer period with no concession given to the control limit. Where both 4 hour and shorter samples are available for the same situation, the 4 hour sample should be used to assess compliance with the control limit. (para 173)

Recommendation 14: we recommend that the control limit for exposure to dust from activities involving crocidolite asbestos should be 0.2 fibres/ml for a 4 hour sampling period, subject to recommendations 9, 11 and 12 above. (para 178)

Recommendation 15: we recommend that the control limit for exposure to dust from chrysotile asbestos should with legal backing become 1 fibre/ml by 1 December 1980, subject to recommendations 10, 12 and 13 (para 195).

Recommendation 16: we recommend that the Health and Safety Executive should examine with the representatives of the employers and employees concerned those particular processes where there appear to be difficulties in meeting the timetable recommended for the application of the control limit for exposure to dust from chrysotile asbestos (para 197).

Recommendation 17: we recommend that the control limit for exposure to dust from amosite asbestos should, with legal backing, become 0.5 fibres/ml by 1 December 1980, subject to recommendations 10, 12 and 13 (para 210).

Recommendation 18: we recommend that the Health and Safety Executive should examine with the representatives of the employers and employees concerned those particular processes where there appear to be difficulties in meeting the timetable recommended for the application of the control limit for exposure to dust from amosite asbestos (para 211).

Recommendation 19: we recommend that the Health and Safety Commission should refer our report to the Advisory Committee on Toxic Substances, invite it to monitor and evaluate the results of the research we have proposed, and to review the recommended control limits as further information becomes available (para 217).

Recommendation 20: we recommend that the Government should press for similar standards of control for asbestos with other countries, particularly within the EEC, and through international organisations such as the ILO and WHO, along the lines we have recommended (para 218).

Recommendation 21: we recommend that there should be an obligation on an employer to arrange for dust estimations to be carried out at such places and at such intervals as are necessary for the purpose of (a) ascertaining the effectiveness of his method of restricting the exposure of employees to asbestos dust and (b) testing the efficacy of engineering methods for the control of dust, especially exhaust ventilation equipment (para 220).

Recommendation 22: we recommend that, in view of the importance of maintaining and servicing ventilation subject to recommendations 10, 12 and 13 (para 195). and test it should be trained to a specified standard (para 225).

Recommendation 23: we recommend that the requirement to provide protective clothing and respiratory protective equipment should be explicitly stated in regulations and extended to include any workers whose person or personal clothing is liable to be significantly contaminated with asbestos dust (para 227).

Recommendation 24: we recommend that suitable changing and washing facilities should be provided at all places where protective clothing is required (para 228).

Recommendation 25: we recommend that there should be an explicit prohibition on the cleaning in workers' homes of the protective clothing required to be issued for work with asbestos (para 229).

Recommendation 26: we recommend that, so far as is reasonably practicable, areas or workplaces where dust concentration does or is likely to exceed the control limit should be suitably marked and a scheme for restricting access to them instituted (para 230).

Recommendation 27: we recommend that all people whose work is liable to expose them regularly to asbestos dust should be advised to refrain from smoking (para 233).

Recommendation 28: we recommend that the two existing schemes of medical supervision should be replaced by a single one with the features as follows:

(a) a single organisation will be responsible for running the scheme and for seeing that medical records are maintained;

(b) employers will be legally required to inform the organisation of anyone currently in or entering employment where precautionary measures have to be taken regularly to ensure compliance with the Asbestos Regulation and to provide facilities for him to be medically examined;

(c) workers will undergo an initial examination on entering employment and periodic examinations thereafter at appropriate intervals determined by the organising body but probably not greater than two years;

(d) the worker, the overseeing organisation and (if the worker agrees) his employer, his general practitioner and the works medical officer (if any) will be informed of any adverse effect discovered in the course of an examination;

(e) the causes of death of workers involved will be recorded so that the epidemiological aim of the scheme can be achieved;

(f) records will be kept in a form suitable for fulfilling both the stated aims (individual protection and epidemiology) including, eg, as much information as is reasonably practicable about exposure to asbestos dust (para 234).

Recommendation 29: we recommend that a regulation should be made under the Health and Safety at Work etc. Act requiring employers to co-operate in the EMAS survey by informing EMAS of anyone currently in or entering employment where precautionary measures have to be taken to comply with the Asbestos Regulations and provide facilities for him to be medically examined (para 237).

Recommendation 30: we recommend that, if Recommendation 29 is implemented, the requirement for initial and periodic medical examination of asbestos workers under the Social Security (Industrial Injuries) (Prescribed Diseases) Regulations 1975 should be repealed (para 239).

Recommendation 31: we recommend that the EMAS should have the power to authorise doctors other than their own staff to conduct the medical supervision of asbestos workers, subject to suitable training and guidance (para 240).

New proposals on legal and administrative controls for the general public

Recommendation 32: we recommend that the asbestos dust emissions from workplaces should be subject to more specific control and that special attention should be given to the possibility of scheduling a class of asbestos works under appropriate legislation (para 243).

Recommendation 33: we recommend that, if Recommendation 32 is implemented, designated and especially scheduled works which emit asbestos dust into the atmosphere should measure such emissions regularly and systematically and keep appropriate records (para 245).

Recommendation 34: we recommend that when the Government's monitoring programme on asbestos in the general atmosphere is complete, the data be assessed by the appropriate public bodies in the light of the medical evidence to determine whether any further action is needed (para 246).

Recommendation 35: we recommend that a new legal obligation should be introduced so that from 1 December 1980 no raw asbestos may be imported into the UK unless it is shipped in totally enclosed metal-clad non-ventilated ISO general purpose freight containers (para 249).

Recommendation 36: we recommend that raw asbestos fibre and other loads liable to give rise to asbestos dust should be transported only in such a way as to prevent the escape of any such dust (para 250).

Recommendation 37: we recommend that waste disposal authorities should have powers (similar to those under Section 16 of the Control of Pollution Act 1974) to identify a disused tip where asbestos is thought to be a hazard, to carry out the necessary works to render it safe and to recoup the expense from the occupier or depositor wherever possible (para 253).

Recommendation 38: we recommend that if experience shows that voluntary compliance with the present labelling scheme for consumer products containing asbestos is inadequate, it should be made obligatory by appropriate regulations (para 259).

Recommendation 39: we recommend that there should be a regular review of information concerning risks to health from the contamination of food and drink by asbestos (para 263).

Recommendation 40: we recommend that all the existing requirements, regulations, codes of practice and guidance notes relating to asbestos should be brought together in one publication (para 264).

Recommendation 41: we recommend that relevant legislation should be examined with a view to reducing the statutory limitations on the disclosure of information relating to asbestos (para 265).

Summary of recommendations from the First Report of the Advisory Committee

Work on Thermal and Acoustic Insulation and Sprayed Coatings

Recommendation 1: it should be an offence to apply asbestos or any products containing it by means of a spray process (paras 21, 35).

Recommendation 2: a ban should be put on the use of materials containing asbestos for any new thermal or acoustic insulation except in any limited applications for which suitable substitutes are not yet available. This recommendation would not affect products which may have thermal or acoustic insulation properties incidental to their main functions, such as asbestos cement and fire protection board (paras 4, 22, 23, 36).

Recommendation 3: it should be an offence for an employer or a self-employed person to undertake work involving existing sprayed coatings, or any form of thermal or acoustic insulation containing asbestos, on behalf of clients or on his own account in other persons' premises, or on premises owned by him but occupied by other people, unless he holds a current licence to do so. Licences would be issued by the Health and Safety Executive on the basis of information supplied by applicants and could be revoked by the Executive if the information so supplied was false, if the conditions of the licence were broken, or if a licensee was found guilty of a contravention of statutory provisions relating to asbestos. Potential licensees should have a right to appeal against the refusal to grant a licence or its revocation.

The licensing requirements would not apply to employers or self-employed persons who carry out such work on their own behalf in their own premises nor to work involving casual contact with small quantities of asbestos-based insulation (paras 24–29, 37–39).

Recommendation 4: a Code of Practice should be issued and approved under Section 16 of the Health and Safety at Work etc. Act providing practical advice on the precautions to be observed in work involving sprayed coatings and asbestos-based thermal and acoustic insulation to help people comply with the Asbestos Regulations 1969 (paras 31, 40).

Recommendation 5: the Health and Safety Executive should have the power to require any licensee to notify them in advance of jobs involving work with asbestos for which a licence is required (paras 32, 41).

Summary of recommendations from the Second Report of the Advisory Committee

Measurement and Monitoring of Asbestos in Air

MONITORING IN THE WORKPLACE

Recommendation 1: the membrane filter method should be retained as the standard method of sampling for comparing occupational exposure to airborne asbestos dust with the current hygiene standards until better alternatives are tried, proved and correlated with it (paras 14–38, 57).

Recommendation 2: a central reference laboratory should be nominated to carry out and publish the results of intercomparisons of counting procedures both within and between laboratories with the objective of minimising systematic and random errors during the evaluation of membrane filter samples (paras 31, 59–60).

Recommendation 3: the progress made by the Laboratory of the Government Chemist in the use of semi-automatic methods for the evaluation of membrane filter samples should be consolidated and the development of other automatic methods encouraged (paras 39, 61–62).

Recommendation 4: operational monitoring programmes should be reviewed with a view to obtaining maximum information from this source to supplement the data obtained from other epidemiological studies such as the Employment Medical Advisory Service (EMAS) survey of asbestos workers (paras 9–10, 63–64).

Recommendation 5: a survey should be carried out to determine the full shape and size distributions of airborne fibres from an appropriate selection of products and processes (paras 40, 65).

MONITORING OUTSIDE THE WORKPLACE

Recommendation 6: a guidance note on the standardisation of sampling and evaluation technique for dust concentrations discharged into the atmosphere should be prepared so that employers can check the efficiency of exhaust systems in a regular and uniform manner (paras 43–54, 66).

Recommendation 7: a programme of work should be prepared to evaluate asbestos exposure in the non-occupational environment. A preliminary survey should be planned to make best use of resources so that it is directed to places in the non-occupational environment where contamination with asbestos dust is likely to be highest and where information is most quickly needed (paras 55–56, 67–79).

Recommendation 8: funds should be made available to fulfil the proposals put forward and the work should be co-ordinated by the funding organisations (Appendix 4, para 70).

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Asbestos

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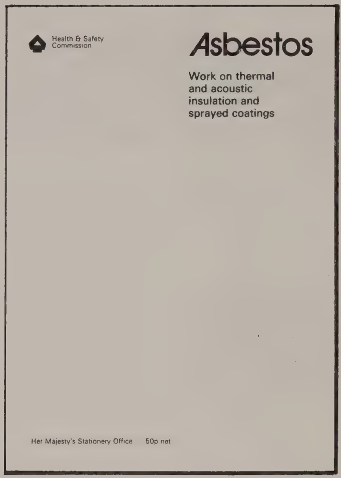
In March 1976, Michael Foot, the then Secretary of State for Employment announced that the Health and Safety Commission would set up a committee

"to review the risk to health arising from exposure to asbestos, or products containing asbestos, including: persons exposed at work; members of the public exposed to asbestos generated from work activities; members of the public exposed to asbestos products and waste; and to make recommendations as to whether any further protection is required".

The committee, chaired by Bill Simpson, and including representatives of workers, employers, consumers, local authorities, medical and scientific experts, has published its final report and this booklet summarises the recommendations made in it and the two previous reports.

The booklet is not a substitute for the reports, and the recommendations should be considered in the context of the discussions contained in them.



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and acoustic
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Asbestos: Work on thermal and acoustic insulation and sprayed coatings 16pp + cover (published by HMSO June 1978 price 50p)

Recommendations

1 It should be an offence to apply asbestos or any product containing it by means of a spray process.(paras 21 and 35)

2 A ban should be put on the use of materials containing asbestos for any new thermal or acoustic insulation except in any limited applications for which suitable substitutes are not yet available. This recommendation would not affect products which may have thermal or acoustic insulation properties incidental to their main functions, such as asbestos cement and fire protection board.(paras 4, 22, 23 and 36)

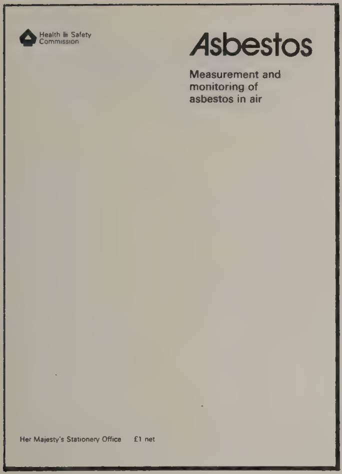
3 It should be an offence for an employer or a self-employed person to undertake work involving existing sprayed coatings, or any form of thermal or acoustic insulation containing asbestos, on behalf of clients or on his own account in other persons' premises owned by him but occupied by other people, unless he holds a current licence to do so.

Licences would be issued by the Health and Safety Executive on the basis of information supplied by applicants and could be revoked by the Executive if the information so supplied was false, if the conditions of the licence were broken, or if a licensee was found guilty of a contravention of statutory provisions relating to asbestos. Potential licencees should have a right to appeal against the refusal to grant a licence or its revocation.

The licensing requirements would not apply to employers or self-employed persons who carry out such work on their own behalf in their own premises nor to work involving casual contact with small quantities of asbestos-based insulation.(paras 24-29 and 37-39)

4 A code of practice should be issued and approved under Section 16 of the Health and Safety at Work etc Act providing practical advice on the precautions to be observed in work involving spayed coatings and asbestos-based thermal and acoustic insulation to help people comply with the Asbestos Regulations 1969. (paras 31 and 40)

5 The Health and Safety Executive should have the power to require any licensee to notify them in advance of jobs involving work with asbestos for which a licence is required.(paras 32 and 41)



Health & Safety Commission

Asbestos

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Asbestos: Measurement and monitoring of asbestos in air 28pp + cover (published by HMSO June 1978 price £1)

Recommendations

Monitoring in the workplace

1 The membrane filter method should be retained as the standard method of sampling for comparing occupational exposure to airborne asbestos dust with the current hygiene standards until better alternatives are tried, proved and correlated with it. (paras 14-38 and 57)

Sample evaluation

2 A central reference laboratory should be nominated to carry out and publish the results of intercomparisons of counting procedures both within and between laboratories with the objective of minimising systematic and random errors during the evaluation of membrane filter samples. (paras 31 and 59-60)

3 The progress made by the Laboratory of the Government Chemist in the use of semi-automatic methods for the evaluation of membrane filter samples should be consolidated and the development of other automatic methods encouraged. (paras 39 and 61-62)

Design of monitoring programmes

4 Operational monitoring programmes should be reviewed with a view to obtaining maximum information from the source to supplement the data obtained from other epidemiological studies such as the Employment Medical Advisory Service survey of asbestos workers. (paras 9-10, and 63-64)

5 A survey should be carried out to determine the full shape and size distributions of airborne fibres from an appropriate selection of products and processes. (paras 40 and 65)

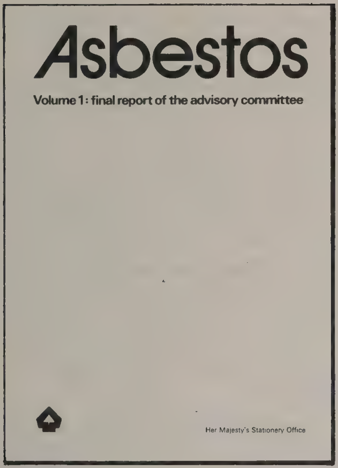
Monitoring outside the workplace

6 A guidance note on the standardisation of sampling and evaluation techniques for dust concentrations discharged into the atmosphere should be prepared so that employers can check the efficiency of exhaust systems in a regular and uniform manner.(paras 43-54 and 66)

7 A programme of work should be prepared to evaluate asbestos exposure in the non-occupational environment. A preliminary survey should be planned to make best use of resources so that it is directed to places in the non-occupational environment where contamination with asbestos dust is likely to be highest and where information is most quickly needed.(paras 55-56 and 67-69)

Research

8 Funds should be made available to fulfil the proposals put forward and the work should be co-ordinated by the funding organisations.(Appendix 4, para 70)


Asbestos

Volume 1: final report of the advisory committee

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Asbestos

Volume 1: final report of the advisory committee 100pp + cover

Volume 2: papers prepared for the advisory committee 104pp + cover

Recommendations

Legal and administrative controls

In the workplace

Prohibition

1 There should be a statutory ban on the import of raw crocidolite fibre to prevent its re-introduction into the UK and this should be extended to the import of products containing it. (para 143)

Identification

2 The term 'containing crocidolite' should be defined and the definition should specify the technique or techniques of analysis to be used and the criteria for deciding whether crocidolite is present. (para 144)

3 If as at present an employer chooses to treat a given substance as containing crocidolite, he should continue to be under no obligation to carry out tests to determine whether crocidolite is in fact present. (para 145).

4 If an employer does not treat a substance as containing crocidolite, the onus should be on him to show that crocidolite is not present if his action is challenged. (para 145)

Substitution

5 An explicit obligation should be placed on any person who produces specifications for or carries on a process involving the use of asbestos or any product containing it to consider the substitution of asbestos by other materials so far as it is reasonably practical to do so. When doing this he should weigh the relative advantages of asbestos and potential substitutes, taking into account current knowledge about potential health risks, suitability in the production and performance of the finished product and costs associated with the change. (para 153)

6 The Health and Safety Executive, or the Health and Safety Commission as advised by its Advisory Committee on Toxic Substances, should provide and publish advice on the general principles involved in conducting the evaluation and data on particular possible substitutes. (para 154)

7 The Health and Safety Executive or the Health and Safety Commission, when framing its advice and future policy on substitutes for asbestos, should take into account the social costs of obtaining, using and disposing of asbestos as well as the costs and benefits which can be more easily identified and forecast. (para 157)

Control limits: critiera for determination

8 The term 'hygiene standard' should be replaced by 'control limit' for the assessment of exposure to asbestos dust. (para 161)

9 A single control limit for each type of asbestos should be applied to all processes involving asbestos or products containing it, and this set of limits should have legal backing. (para 165)

10 Legislation should be prepared making clear an overriding requirement to reduce exposure to asbestos dust to the minimum that is reasonably practicable. (para 166)

Control limits: sampling and evaluation

11 For the purposes of assessing compliance with control limits, industry, enforcing authorities and others should use personal sampling with the membrane filter method. (para 168)

12 The control limit for each type of asbestos could most reasonably be applied to the result of measurements taken during a 4-hour sampling period. (para 172)

13 Where it is not reasonably practicable or appropriate to collect information covering the whole four-hour sampling period, the shorter sample decided upon should be treated as representative of the longer period with no concession given to the control limit. Where both four-hour and shorter samples are available for the same situation, the four-hour sample should be used to assess compliance with the control limit. (para 173)

Control limits: application of critieria

14 The control limit for exposure to dust from existing applications of crocidolite asbestos should be 0·2 fibres/ml for a four-hour sampling period, subject to recommendations 10, 12 and 13 above. (para 178)

15 The control limit for exposure to dust from chrysotile asbestos should with legal backing become 1 fibre/ml by 1 December 1980, subject to recommendations 10, 12 and 13 above. (para 195)

16 The Health and Safety Executive should examine with the representatives of the employers and employees concerned those particular processes where there appear to be difficulties in meeting the timetable recommended for the application of the control limit for exposure to dust from chrysotile asbestos. (para 197)

17 The control limit for exposure to dust from amosite asbestos should, with legal backing, become 0·5 fibres/ml by 1 December 1980, subject to recommendations 10, 12 and 13 above. (para 210)

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Control limits: a longer-term solution

19 The Health and Safety Commission should refer to the Advisory Committee on Toxic Substances, invite it to monitor and evaluate the results of the research we have proposed, and to review the recommended control limits as further information becomes available. (para 217)

20 The government should press for similar standards of control for asbestos with other countries, particularly within the EEC, and through international organisations such as the ILO and WHO, along the lines we have recommended. (para 218)

Other controls in the workplace

21 There should be an obligation on an employer to arrange for dust estimations to be carried out at such places and at such intervals as are necessary for the purpose of: ascertaining the effectiveness of his method of restricting the exposure of employees to asbestos dust: and testing the efficiency of engineering methods for the control of dust, especially exhaust ventilation equipment. (para 220)

22 In view of the importance of maintaining and servicing ventilation equipment to a high state of efficiency, people who examine and test it should be trained to a specified standard. (para 225)

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27 All people whose work is liable to expose them regularly to asbestos dust should be advised to refrain from smoking. (para 233)

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(e) the causes of death of workers involved recorded so the epidemiological aim of the scheme can be achieved;

(f) records kept in a form suitable for fulfilling both the stated aims (individual protection and epidemiology including, e.g. as much information as is reasonably practicable about exposure to asbestos dust. (para 234-5)

29 A regulation should be made under the Health and Safety at Work etc Act requiring employers to cooperate in the EMAS survey by informing EMAS of anyone currently in or entering employment where precautionary measures have to be taken to comply with the Asbestos Regulations and provide facilities for him to be medically examined. (para 237)

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38 If experience shows that voluntary compliance with the present labelling scheme for consumer products containing asbestos is inadequate, it should be made obligatory by appropriate regulations. (para 259)

Food and drink

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Information

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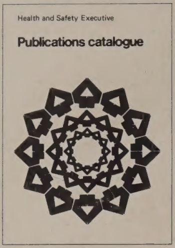
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